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ABSTRACT

This document targets upper elementary and middle school students and provides activities to understand what the ocean floor looks like, the interactions of ocean communities, and the true nature of sharks. The activities are developed at three levels: beginner, intermediate, and advanced. The twelve activities include: (1) "Ocean Detectives"; (2) "Make a Mountain"; (3) "Ocean Motion"; (4) "Sea Around You"; (5) "Rock Reef Critters"; (6) "Ahoy! It's an Island"; (7) "Take a Dive"; (8) "Shark Parts"; (9) "A Dentist's Dream"; (10) "Smelly? Not!"; (11) "Fishing for Dinner"; and (12) "Shark Folklore." Career information and resources are also included. (YDS)

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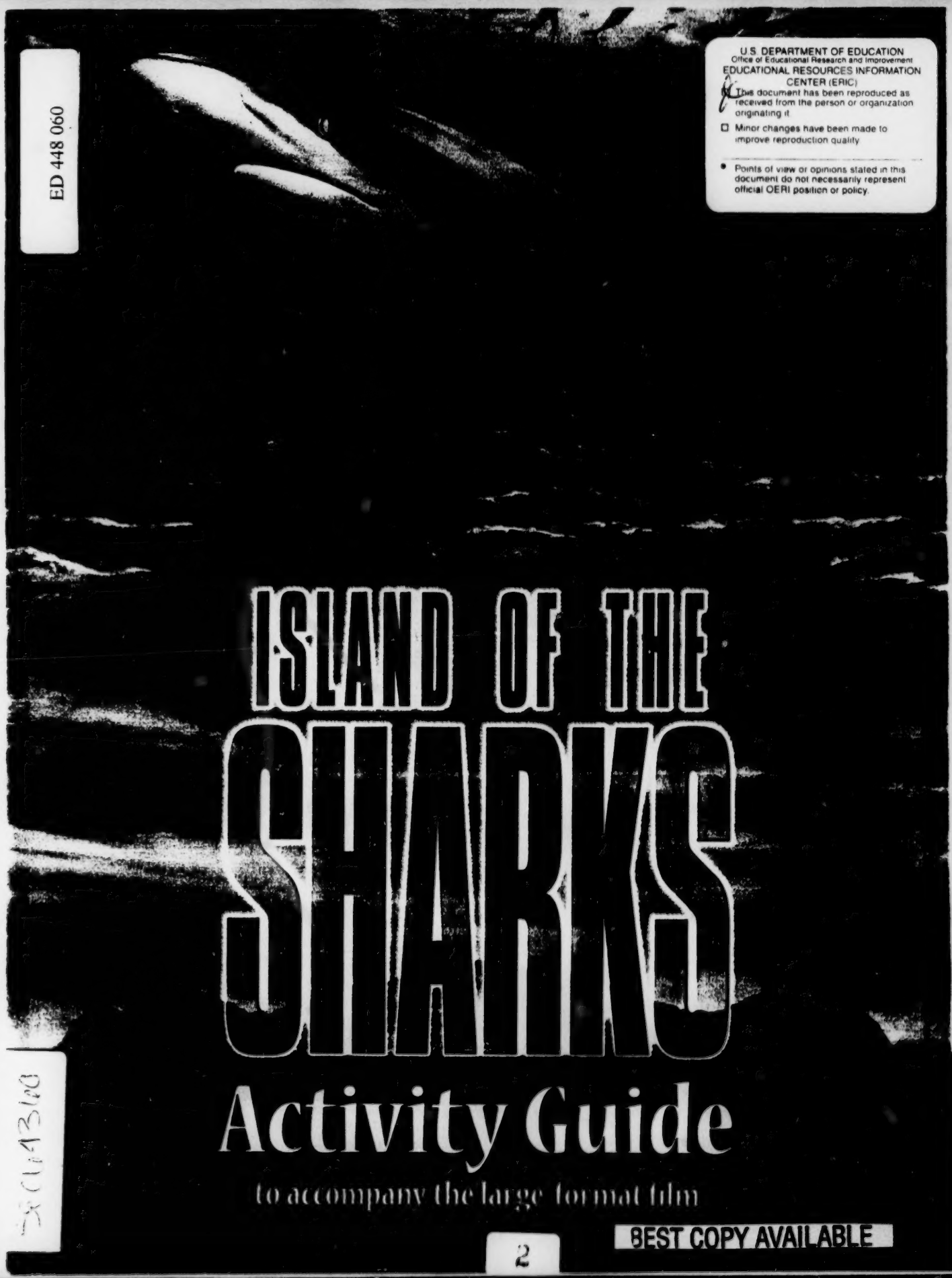

ISLAND OF THE SHARKS

Activity Guide

to accompany the large format film

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Dive In!

Want to go where few people on earth have ever been?

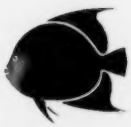
Then step into the watery world of the large-format film *Island of the Sharks*, where you'll find yourself gliding alongside giant manta rays, watching reef fish practice courtship, or swimming among hundreds of hammerhead sharks.

This magical place is Cocos Island, an uninhabited rainforest paradise 300 miles west of Costa Rica. Legendary for rumored stashes of pirate gold, Cocos has inspired the settings for Robert Louis Stevenson's *Treasure Island* and Michael Crichton's *Jurassic Park*.

The waters around Cocos Island boast the world's highest concentration of large marine predators, swarming with more sharks per cubic meter of water than any place else on earth. In addition to these top predators, an abundance of sea life swims the island's waters. Vibrant tropical reef fish and moray eels abound, as well as animals like tuna, sharks, and marbled sting rays that travel hundreds of miles to congregate there.

The film highlights the lives of these animals. According to film producer Michele Hall, "The strength of the film is bringing animal behavior to the screen. Not only do you see beautiful animals, you see what they're doing. We want to give people a sense of the lives of marine life so that they appreciate it more, and hopefully, want to do something to protect our oceans."

This guide accompanies *Island of the Sharks*. Children can complete the activities to prepare to see the film or to reinforce the film's concepts after viewing. The activities will help children understand what the ocean floor looks like, how ocean communities interact, and the true nature of sharks—that there's more to these awesome creatures than what they eat. Students in upper elementary or middle school are just the right age to do these activities.



Where's the Film Playing?

To find out if *Island of the Sharks* is coming soon to your area, call your local large-format theater. For more information about Cocos Island and the making of the film, visit the film's Web site at
www.pbs.org/nova/sharks
or link to it from:
www.imax.com

Table of Contents

The World Ocean

4 Ocean Detectives
Use clues to navigate the world ocean and find out what the underwater landscape looks like.

10 Make a Mountain
Build an underwater mountain or an island and learn about how it was made.

12 Ocean Motion
Use homemade salt water, ice water, and food coloring to discover how deep-water currents move.

Life Down Under

14 Sea around You
Identify items from the sea and learn where they came from.

16 Rock Reef Critters
Create a pop-up scene of the Cocos rock reef to show some of the island's sea creatures in action.

18 Ahoy! It's an Island
Develop an island and consider the conservation issues involved.

20 Take a Dive
Design a land-based scuba dive of the Cocos rock reef and learn about the animals that live there.

All about Sharks

24 Shark Parts
Assemble puzzle pieces and learn the body parts of a hammerhead shark.

25 A Dentist's Dream
Measure a triangular shark tooth and figure out how big its owner was.

26 Smelly? Not!
Create different-strength vinegar solutions to investigate a shark's sense of smell.

27 Fishing for Dinner
Make your own sandbed to learn how rays and sharks use electrical impulses to detect fish and other creatures.

28 Shark Folklore
Read a folktale about a protective shark guardian and then create a story of your own.

Resources

32 Careers
Find out about ocean-related careers, including marine biologist, aquarium staff member, science journalist, and politician.

34 What's Happening
Check here for explanations about what's happening in the activities you've been doing in this guide.

36 Threats to Sharks
Find out what threatens shark populations today and where you can go to learn more about these threats.

Activity Skill Level

: beginner

: intermediate

: advanced

The World Ocean

Look out your window. Do you see an ocean? Probably not.

It may not look like it from where you are sitting, but the earth is covered with water. Nearly three-quarters of its surface is blanketed by five major oceans—the Pacific, Atlantic, Indian, Antarctic, and Arctic—all connected to make one big world ocean.

You may think that beneath the waves, the ocean floor is flat. Not so! The ocean landscape is as varied as that on dry land, as you can see on the facing page. This variety creates many different kinds of places for ocean creatures to live. Just like you may live in a crowded city or suburb with lots of people or a small town where everybody knows everybody else, ocean animals can live on a crowded reef with lots of neighbors or spend most of their time on a big flat plain that's not very crowded.

The ocean is home to various carefully balanced networks, called ecosystems, where everything relies on something else to live. Miles under the ocean surface, the earth opens up and hot chemicals gush out. Seems like an unappealing place to live, yet the blind shrimp, white crabs, giant tubeworms, and other creatures there thrive in this dark world. In shallower waters, coral and rock reefs like those around Cocos Island provide the animals there with everything they need to survive—sunlight, food, and places to hide and live.

But not all animals stay in one place. Many roam the ocean, stopping at certain places to eat or mate or give birth, and then head on their way again. Some animals move from place to place but no one is exactly sure why. The hammerhead sharks at Cocos Island are one such animal. They gather in large schools at Cocos for months at a time before heading on. Where they come from, why they are there, or where they go remains a mystery.

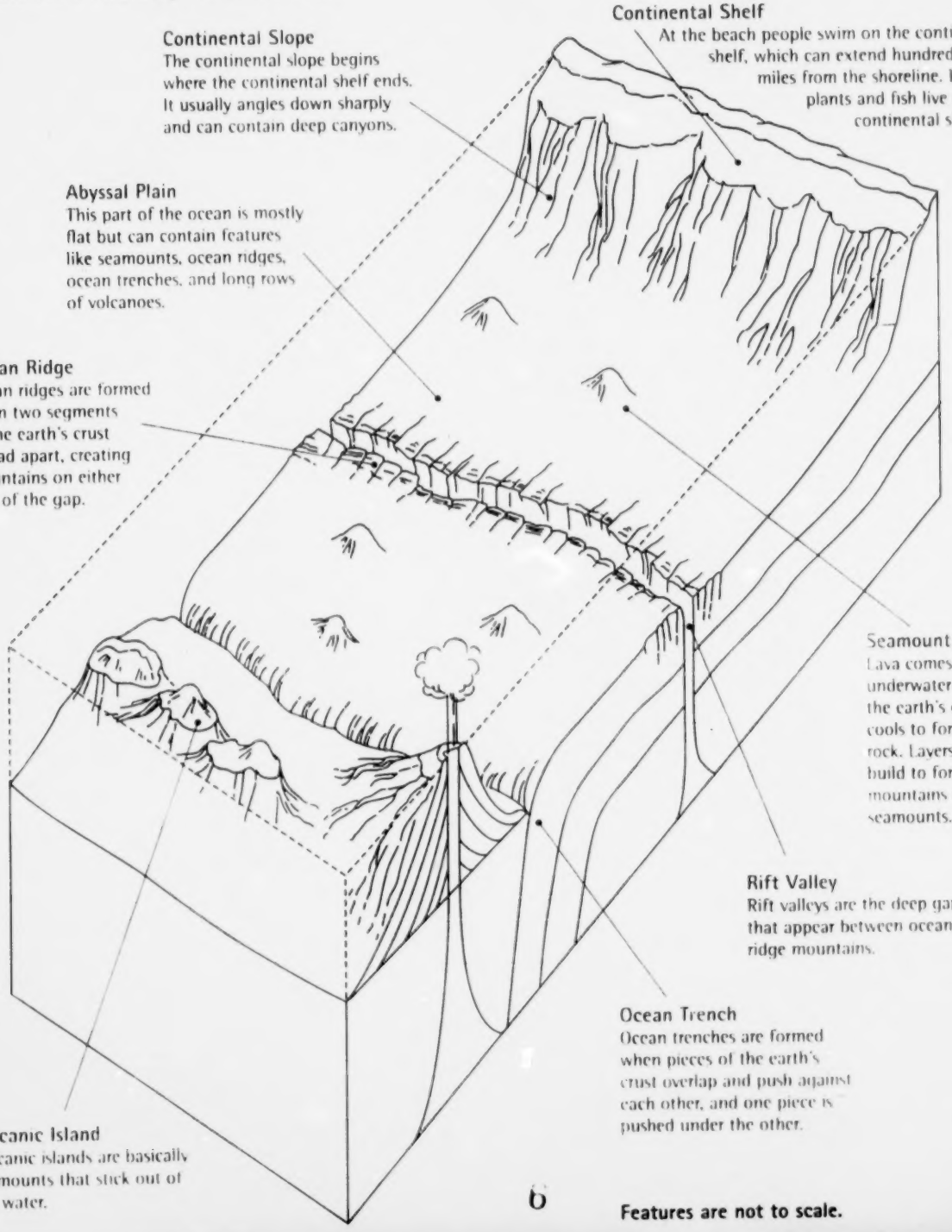
The earth's oceans are filled with questions waiting to be answered. Scientists from around the world are studying how the ocean works, what the creatures are like that live there, how the oceans affect our environment, and much more. Maybe someday you will study the ocean, too!

What Jobs Involve the Ocean?

Want to know about jobs that involve work with the oceans? Check out Careers on page 32.

What's Under All That Water?

Some of the ocean floor is flat, but a lot of it is filled with all kinds of neat things like long mountain ranges, deep canyons and valleys, and large volcanoes. These are just like the ones you see on land. The only difference is that they are under water.



Continental Shelf
At the beach people swim on the continental shelf, which can extend hundreds of miles from the shoreline. Lots of plants and fish live on the continental shelf.

Continental Slope
The continental slope begins where the continental shelf ends. It usually angles down sharply and can contain deep canyons.

Abyssal Plain
This part of the ocean is mostly flat but can contain features like seamounts, ocean ridges, ocean trenches, and long rows of volcanoes.

Ocean Ridge
Ocean ridges are formed when two segments of the earth's crust spread apart, creating mountains on either side of the gap.

Seamount
Lava comes out of underwater cracks in the earth's crust and cools to form solid rock. Layers of lava build to form undersea mountains called seamounts.

Rift Valley
Rift valleys are the deep gaps that appear between ocean ridge mountains.

Ocean Trench
Ocean trenches are formed when pieces of the earth's crust overlap and push against each other, and one piece is pushed under the other.

Volcanic Island
Volcanic islands are basically seamounts that stick out of the water.

Features are not to scale.

Activity Skill Level

Ocean Detectives

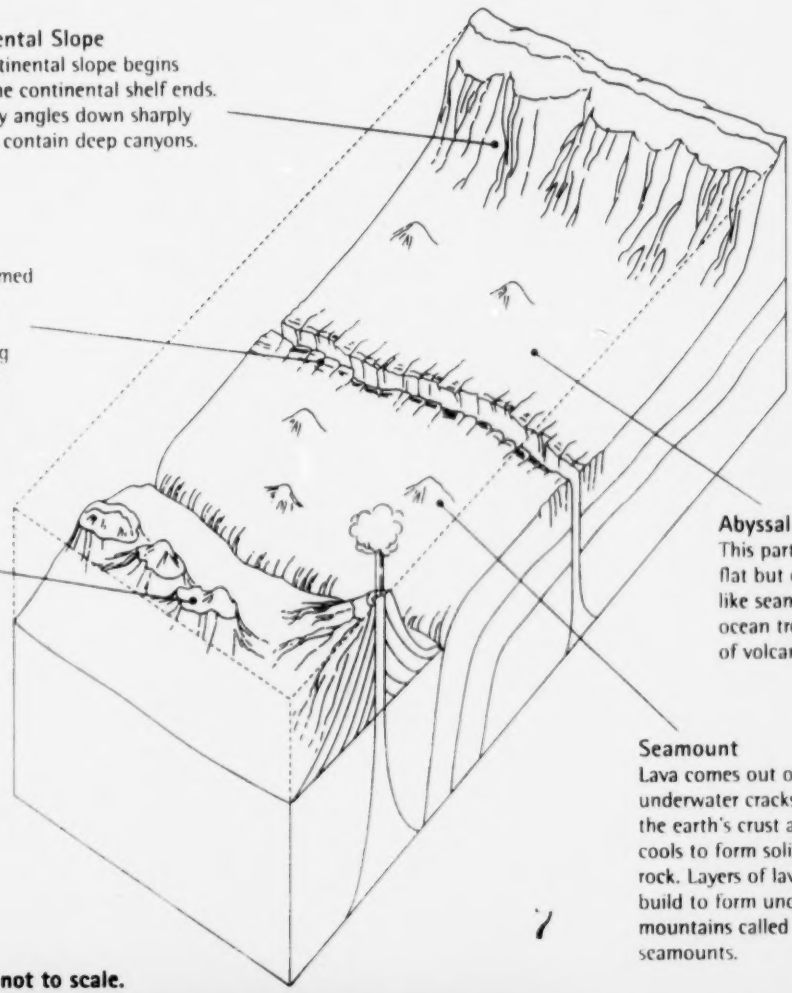
You are a scientist tracking the movement and behavior of several sea animals in the world's oceans. You use a variety of means to find your animals–radio transmitters, tagging, video cameras, direct observation, field reports, and more. As reports about these animals come in, you need to figure out where they have been spotted and map their locations. A new set of reports has just arrived. Read them carefully, then try to determine the current position of each of your animals.

What you'll need

- **Your Reports Are In!** on page 5
- **World Ocean Map** on pages 6–7

How to play

1. Read your first report in **Your Reports Are In!**
2. Use the key on your **World Ocean Map** to find the symbol for the ocean feature you are searching for. Then look for that symbol on the map.
3. Use any geographical hints in the clues to help you locate your creature.
4. When you think you've found your creature, circle its tag number on your map.
5. Once you have finished with all five clues check **What's Your Ocean Notion IQ?** on pages 8–9 to see how you did.



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Features are not to scale.

Your Reports Are In!

Report A

A team of scuba divers have called the tagging network to report that they spotted three hammerhead sharks with yellow tags at a **seamount** in the Pacific Ocean off the coast of southern California. Although the divers were not able to catch the sharks, you know that a group of six hammerheads was tagged with yellow markers just one month ago off Cocos Island, many miles away to the southeast. You think the three that were spotted were members of the same group. Can you find the location where the sharks were spotted by the divers?

Report B

A remote-controlled video camera is patrolling the deep sea, nearly a mile-and-a-half beneath the surface. It has just sent back images of giant, 6-foot tall worms. The worms are clustered around springs of hot water that gush up through cracks in the Pacific Ocean floor in a rift valley in an **ocean ridge** called the Juan de Fuca Ridge. It is located off the west coast of North America. Can you find where the worms are?

Report C

A postcard has come in from a fisherman who caught and released a blue shark that had been tagged. Based on the weight and length information provided by the fisherman, this shark has gained 10 pounds and grown seven inches since it was last tagged. It was caught in tropical waters over the **continental slope** off the eastern coast of Australia. Can you find the position where it was caught?

Report D

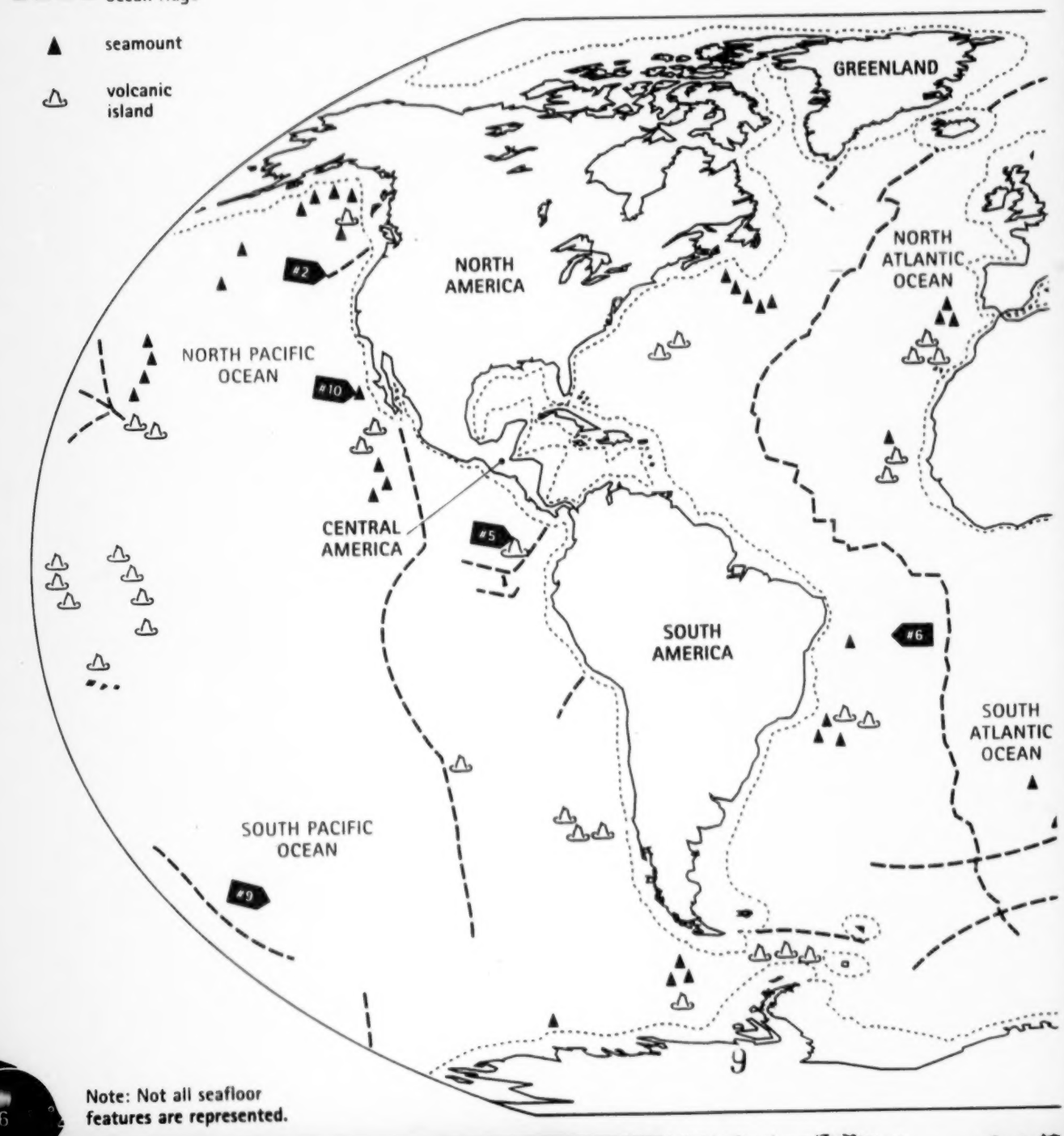
A green sea turtle was tagged with a radio transmitter when she came ashore to nest on a remote island in the South Atlantic called Ascension Island, off the west coast of Africa. After she laid her eggs, she began to migrate west to her feeding grounds in shallow sea grass beds off Brazil. Her signal has been tracked to a position in the middle of the Atlantic Ocean. She is swimming at the surface, but deep below her is an **abyssal plain**. Can you find her position?

Report E

An airmail package has just arrived from Cocos Island, a Costa Rican national park off the western coast of Central America. A park ranger who studies the lava caves on this rock reef has just sent in a report on a school of barberfish. She has studied the animals that live on the rock and coral reefs of this volcanic island for five years and knows their favorite habitats. In this letter she reports on the barberfish who clean parasites off other fish just outside the caves. Can you find the location of these barberfish?

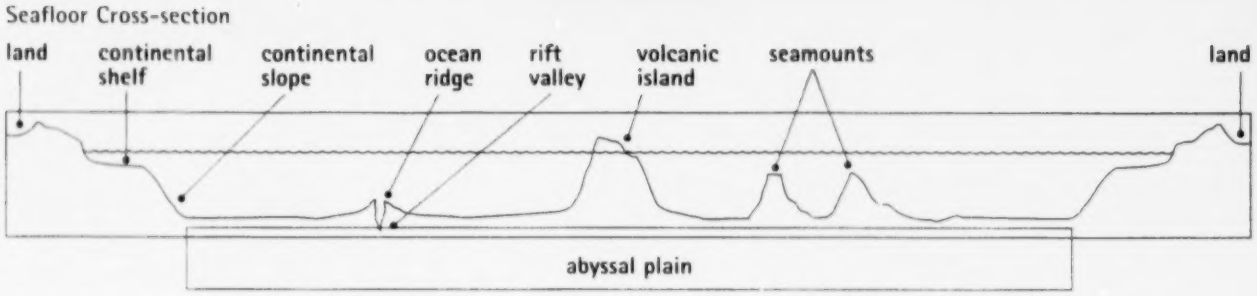
Ocean Detectives

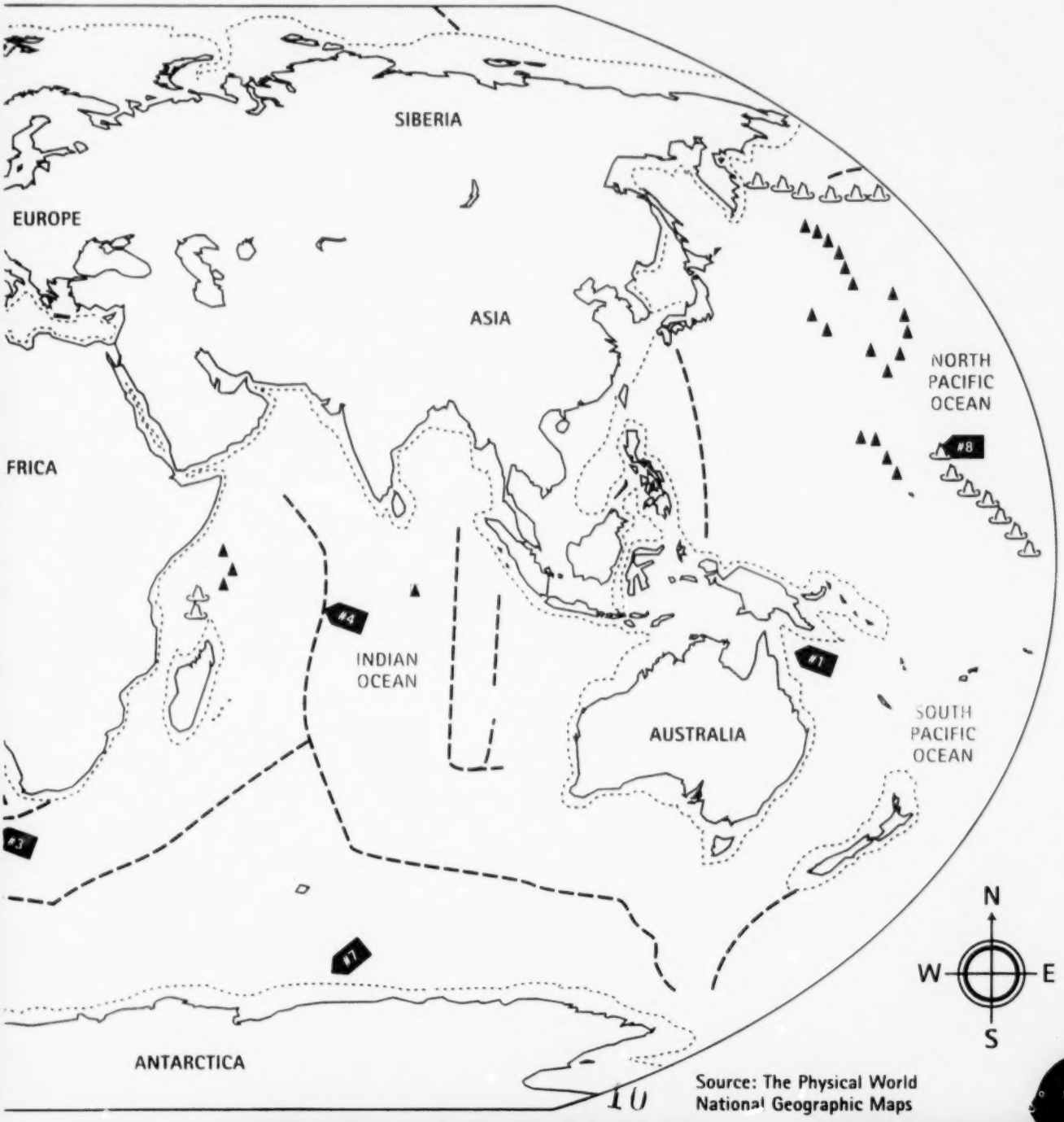
World Ocean Map



Note: Not all seafloor features are represented.

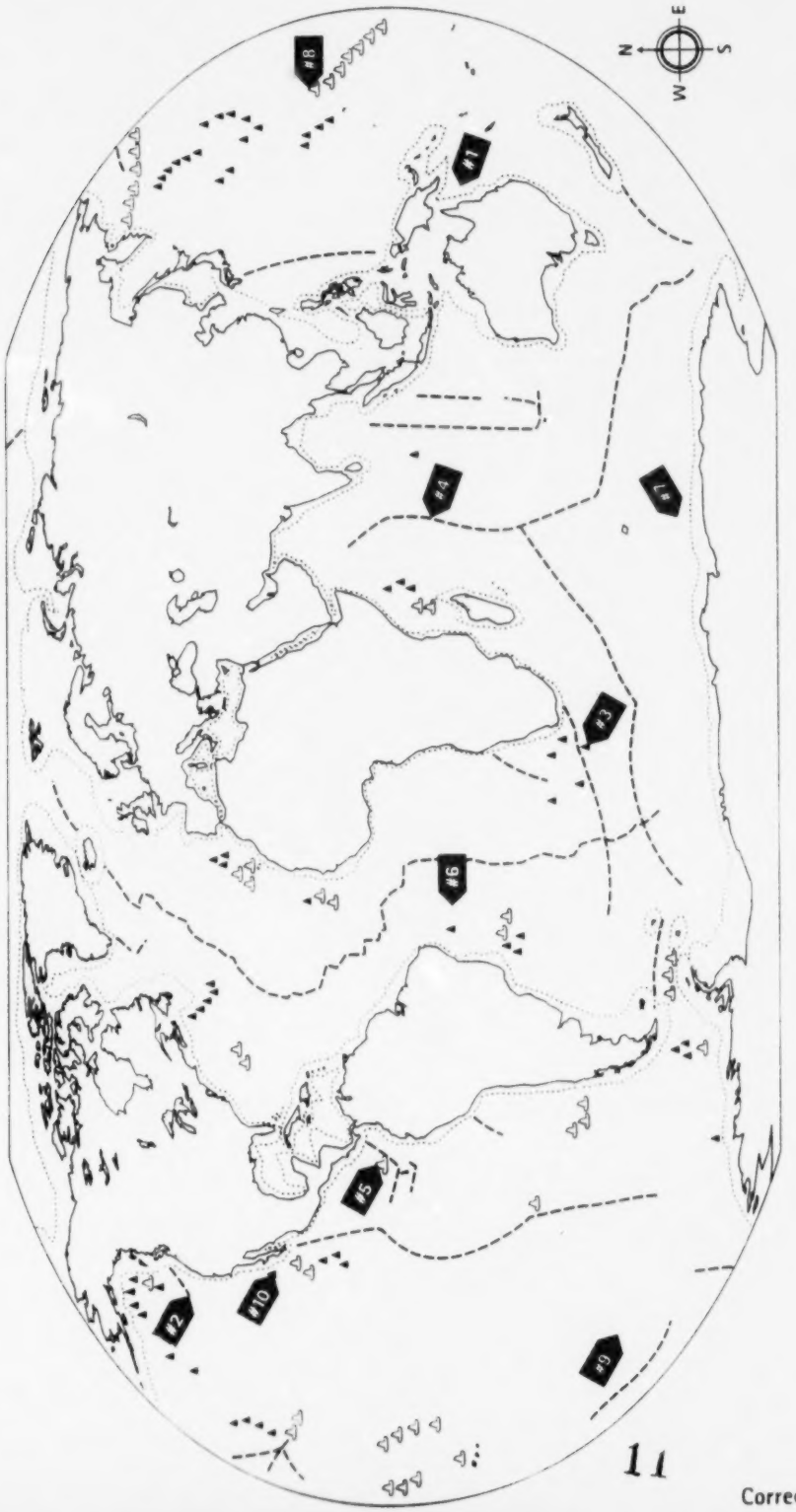
The World Ocean





Source: The Physical World National Geographic Maps

What's Your Ocean Notion IQ?



11

Correct tags are in green.

Report A

Tag #10—Hammerhead Shark

Scientists are not sure why hammerheads migrate or where they go on their travels. These sharks are sometimes spotted around seamounts like those near Cocos or elsewhere in the Pacific Ocean. Perhaps they come to these areas in the sea to feed. Or to visit with cleaners like the barberfish. Some scientists think hammerheads may use magnetic fields in the lava of seamounts and islands as signposts to guide them in their migration.

Hammerhead sharks haven't been found to hang out near the seamounts at Tag #3 in the South Atlantic Ocean.

Report B

Tag #2—Deep Sea Vent Worms

At deep sea vents, superheated water full of chemicals gushes out through cracks in the ocean floor. Bacteria use hydrogen sulfide in the water to make food in a process called chemosynthesis. It is a process similar to photosynthesis, but uses chemicals as an energy source instead of sunlight. Most of the animals that live around the deep sea vents feast on the bacteria. The six-foot-tall worms at the Jaun de Fuca Ridge live with these bacteria inside them.

Deep-sea vent worms might be found at Tag #4 on the Mid-Indian Ridge, but no one knows for sure because much of the 4,000 miles of the earth's undersea mountain ranges and their rifts have yet to be explored.

Report C

Tag #1—Blue Shark

Most sharks migrate in search of food or in response to seasonal changes in water temperature. Some, like the blue shark, may travel thousands of miles. Blue sharks are wide ranging. This one is found on the continental slope off the coast of Australia. Others, like nurse sharks, may live near the same reef their entire lives. Where do sharks go after they are tagged? Scientists can never be sure until the shark is caught again or tracked using radio or satellite tags.

Blue sharks probably wouldn't be found at Tag #7 on Antarctica's continental slope because the water's likely to be too cold.

Report D

Tag #6—Green Sea Turtle

During the mating and nesting season, hundreds of sea turtles can be found on the beaches of Ascension Island. After laying the eggs, the mothers leave. When the eggs hatch, the baby turtles swim off into the ocean, and only return to lay their own eggs. Through tagging, scientists know that some of the Ascension Island turtles migrate thousands of miles to feeding grounds off Brazil.

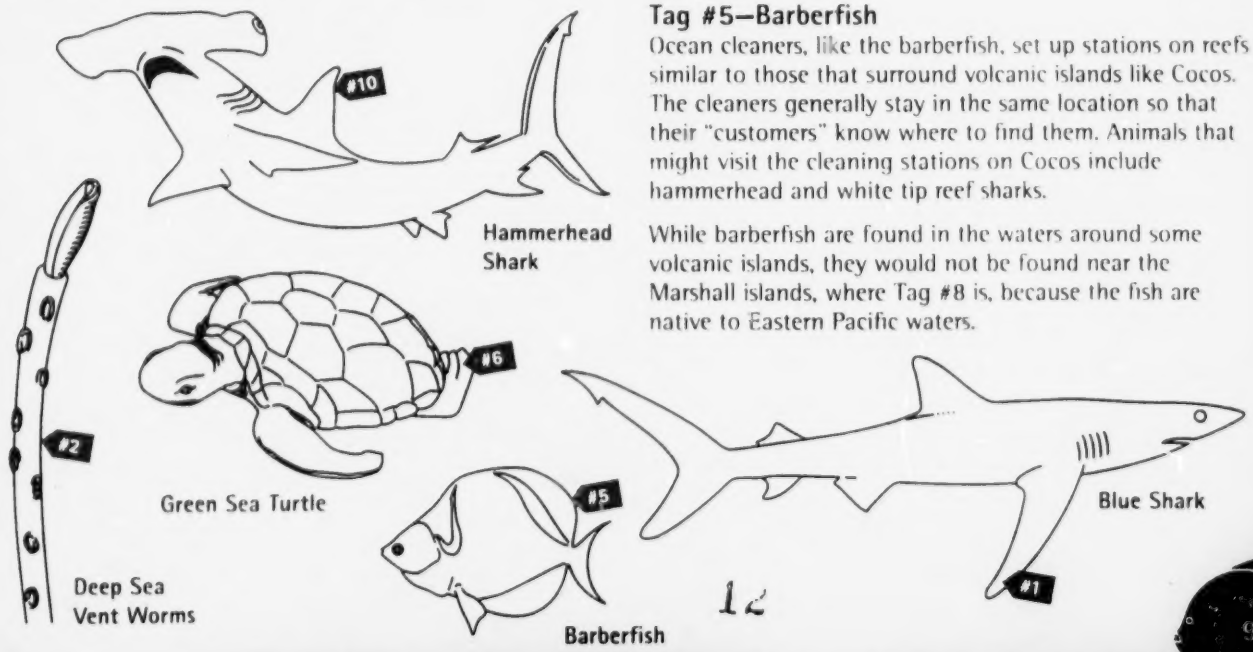
Green sea turtles aren't usually found in the South Pacific's abyssal plain where Tag #9 is.

Report E

Tag #5—Barberfish

Ocean cleaners, like the barberfish, set up stations on reefs similar to those that surround volcanic islands like Cocos. The cleaners generally stay in the same location so that their "customers" know where to find them. Animals that might visit the cleaning stations on Cocos include hammerhead and white tip reef sharks.

While barberfish are found in the waters around some volcanic islands, they would not be found near the Marshall islands, where Tag #8 is, because the fish are native to Eastern Pacific waters.



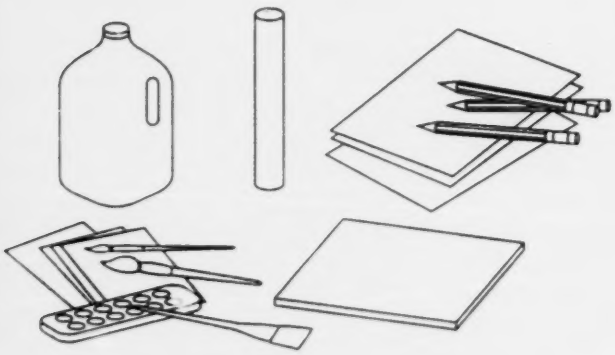
Activity Skill Level

Make a Mountain

You have been hired by a museum to plan a three-dimensional display of seamounts and islands. How are underwater mountains formed? What do they look like? What is the difference between a seamount and an island? Build your own and find out.

What you'll need

- a sturdy base, like a board or a heavy piece of cardboard
- modeling materials such as clay, plaster of Paris, or flour plaster (see recipe below)
- recyclables (for support) such as paper towel rolls, egg cartons, milk jugs, and cardboard boxes—use your imagination!
- pencils and paper
- painting supplies
- Mountains of the Deep on page 11



How to build your mountain

1. Look at the drawings of the different stages of seamount and island formation on page 11. Choose one kind of model to build. Will you use a cross-section to show the birth of a seamount from a submarine volcano? How about a series of "mini" models to show its growth into a volcanic island like Cocos Island? Perhaps you want to show seamounts and islands in a group or a long chain, like the Hawaiian islands. Or maybe you want to build a model to show a seamount that used to be an island but became a seamount again.

2. Once you have decided what you want to build, sketch a design for your model.

3. If you decide to use the flour plaster or plaster of Paris, make your plaster. Then mold your plaster or clay around the recyclables to make your model.

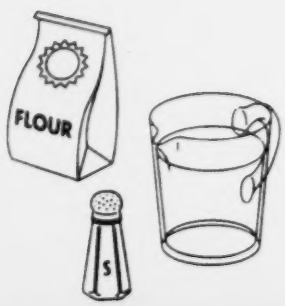
4. When your model is finished, paint it. You might also want to paint a background on paper to put behind your model. Paint your water level first, making sure that all your seamounts are under water, and that your islands are above the water. You can add some fish, turtles, or manta rays to your background as well. You can see what they look like in Dive Field Guide on page 22.

5. Use the information on page 11 to write a display card for your museum model. You might include how seamounts and islands are formed, what they are made from, and why they might be a cool place for fish and other creatures to live.

Flour plaster recipe

2 cups flour
2 cups salt
1 cup water
Mix the ingredients in the order listed. You will have a stiff "plaster" that dries slowly. To speed up drying, bake in a warm oven.

Make sure an adult helps you use the oven.

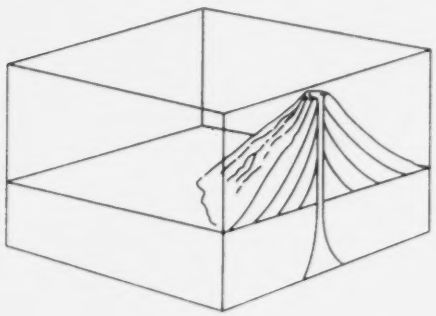


Mountains of the Deep

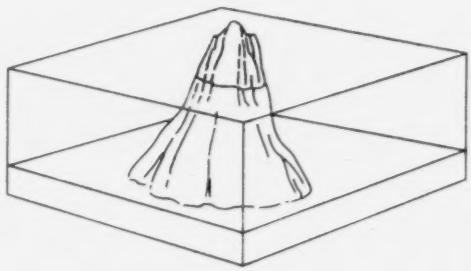
The earth is constantly changing. One way it changes is when molten rock, or lava, comes up through cracks in the ocean floor. The cool ocean water hardens the lava. Layers of hardened lava build up to form underwater mountains. When they are still underwater, these mountains are called seamounts. If they are built up enough to come out of the water, they become islands. Sometimes, for a number of reasons, islands turn back into seamounts.

Like volcanoes on land, seamounts are cone-shaped with steep sides. They may have a pointed or flat top. Most seamounts are in the Pacific Ocean, where more than 10,000 have already been found. Seamounts often form in chains. Cocos Island is part of a seamount chain (but because it comes out of the water, Cocos is considered an island).

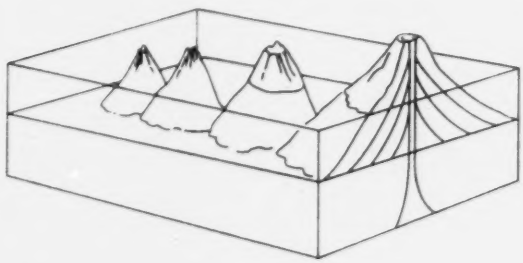
Seamounts and islands can be good places for fish and other animals to find food because their shape forces cold water from deep in the ocean to the surface. This water is filled with organic nutrients from other animals that have died and settled on the ocean bottom. When these nutrients reach the surface, they serve as fertilizer for food eaten by other animals.



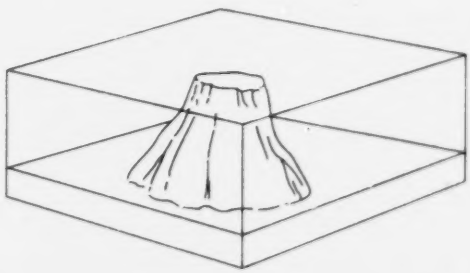
How a seamount is born
Seamounts are born when lava erupts from the earth and hardens to form an underwater mountain.



How a seamount becomes an island
If an underwater mountain continues to build up enough and breaks out above the water it becomes an island.



A row of seamounts and islands
Seamounts and islands are often formed in groups or rows like these.



An island whose top has eroded, turning it into a seamount with a flat top
Sometimes an island becomes a seamount again. This may happen because the land underneath it sinks, submerging the island in water; the sea level changes and covers the island in water; or the top erodes away.

Activity Skill Level

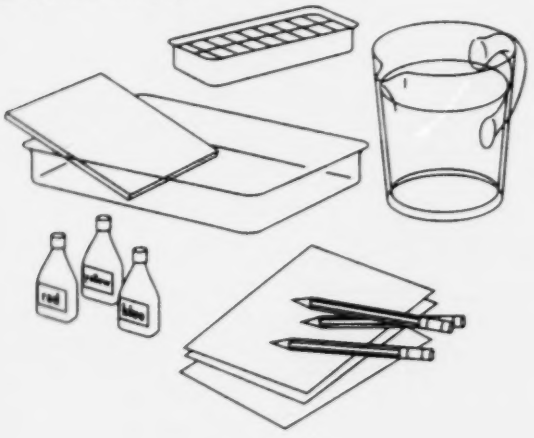
Ocean Motion

The ocean is always in motion. The water is moved by currents, which are large amounts of water going in one direction. There are two main types of currents in the ocean: surface and deep-water currents. Surface currents are created by the wind. Deep-water currents develop for a number of reasons, including the effect of the temperature, saltiness, pressure, and earth's gravity on the water.

Want to make your own ocean in motion? Here is an activity that will show you something about the behavior of cold ocean currents.

What you'll need

- a clear plastic bin, or other large clear container, with sloping board
- warm fresh water (from the tap)
- food coloring (red, yellow, blue)
- homemade salt water (see recipe below)
- ice water
- pencils and paper

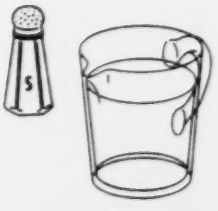


How to make your ocean current

1. Fill the clear plastic bin with warm tap water.
2. Using warm water from the bin, prepare 1 cup of water and add blue food coloring. Pour this water down the slope. Use your pencil and paper to record your observations.
3. Prepare 1 cup of warm salt water and add yellow food coloring. Pour this solution **slowly** down the slope. Record your observations.
4. Prepare 1 cup of ice water and add red food coloring. Pour this solution **slowly** down the slope. Record your observations.
5. What happens when you pour the different solutions in the bin? Why do you think you got the results you did? See how your results compare with those in **What's Happening** on page 34.

Salt water recipe

2 tablespoons of salt
1 cup warm tap water
Pour the salt into the water and stir until it is dissolved.



Life Down Under

Every living thing at Cocos Island has to get some kind of energy in order to survive, just like you do. The start of the who-eats-who cycle begins with nutrients that rise from the deep ocean to the water's surface. These nutrients act as fertilizer for tiny plants floating in the water.

The tiny plants, called phytoplankton, are then eaten by slightly bigger animals, called zooplankton. These, in turn, are eaten by even bigger animals, like sardines and shrimp. The cycle keeps on going, with smaller creatures usually serving as meals for bigger creatures. The animals at the top of the food chain are only eaten by others of their kind (or hunted by humans). One of these animals is the shark.

Not everybody is dinner for somebody else, though. There are cases where animals that would seem to be enemies actually help each other. Take the hammerhead shark and the barberfish, for example. The barberfish actually swim out to greet the hammerhead sharks that come to the reef. The sharks need the barberfish to rid them of parasites. The sharks get cleaned, the barberfish get fed, and both benefit.

Life on the reef goes smoothly until something upsets the balance. This happened recently when the global weather pattern called El Niño struck Cocos, stopping the cold upwelling currents. Without currents bringing nutrients to the surface, the flow of energy into the food web slowed down and cut the food supply. Predators like the hammerheads and rays moved on in search of food elsewhere in the ocean.

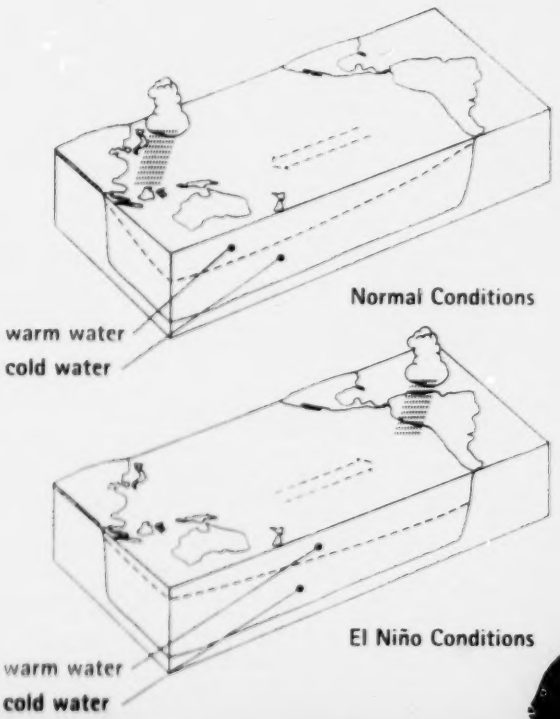
In addition, after months of high temperatures, the corals that build the reef bleached white and died. Many fish starved or swam away. While fish life quickly returned to the reef when El Niño finally ended, the corals may take decades to recover.

What Is El Niño?

El Niño (Spanish for boy child) is a naturally occurring global weather pattern that starts in the eastern Pacific Ocean but has far-reaching effects. During most years, winds in the Pacific blow from east to west. The winds push a warm layer of water at the surface of the ocean away from Central America and Peru toward Asia and Australia. Cold water from the deep ocean moves up to take its place.

But in El Niño years, the winds die down. The warm water flows back from Asia and Australia and pushes the cold waters down. Mixing of cold and warm water stops and for months the eastern Pacific becomes a pool of warm water. Then, just as suddenly as it stopped, the winds start up again and mixing begins again, bringing cold waters back to the surface.

The El Niño cycle repeats every two to seven years. The El Niño of 1997–98, which caused a lot of damage to the wildlife of the Cocos Island reef, was the strongest in more than 20 years. It caused floods in California and droughts in Australia, and wreaked havoc on weather patterns worldwide.



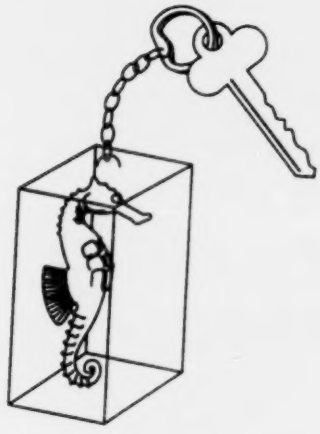
Activity Skill Level

Sea around You

For thousands of years people have used the sea—for food, for transportation, and for fun. Most of us still use something that had its start in the sea. What do you use that comes from the sea? Take a look at the pictures below.

Circle the items that you think came from the sea and then check What's Happening on page 34 to see if you were right. Do you see anything that you used today? How about this week? This year? Did you know that it might have had its start in the ocean?

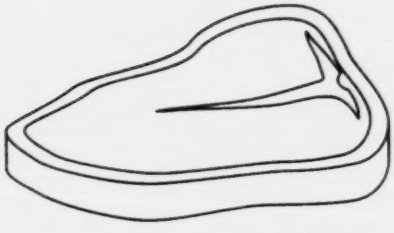
Pearl Necklace



Seahorse Key Chain

Salt

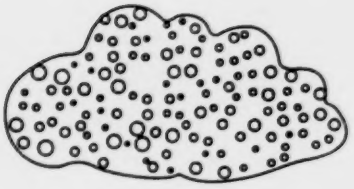
Pepper



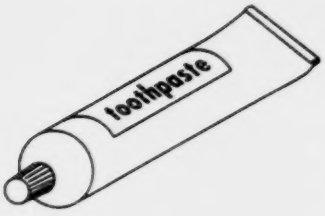
Steak

Sea around You

Toothbrush



Sponge



Purse

Celery

Activity Skill Level

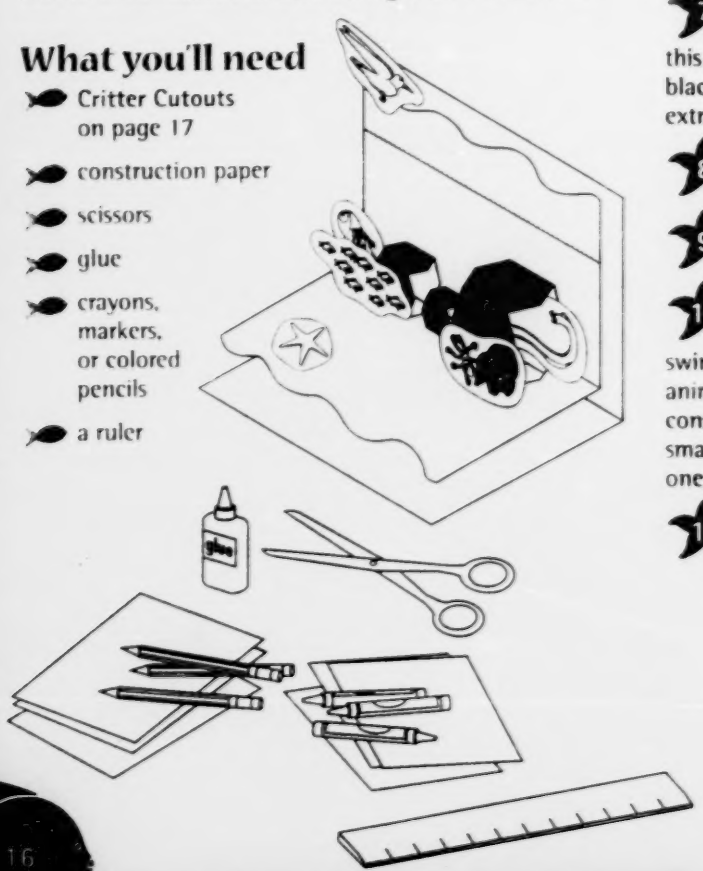
Rock Reef Critters

Here's a fun way to create a pop-up scene of Cocos Island that will show some of the island's creatures in action. The scene (or habitat) is a rock reef located in shallow water (about 30 feet deep). Unlike coral reefs, rock reefs like the ones around Cocos are primarily made of volcanic rock. A coral reef is made up mostly of live animal colonies called corals.

Fish of all sizes, shapes, and colors live in the rock reef. They find protection from larger predators in the caves and tunnels while they hunt for food. The reef is also home to many animals like sea stars, sponges, and corals. Moray eels hide in the reef caves during the day and come out at night to hunt for spiny lobsters, sleeping fish, and other creatures. Fairy terns from the island fly over the water in search of food and swoop down on the rock reef to catch fish swimming near the surface.

What you'll need

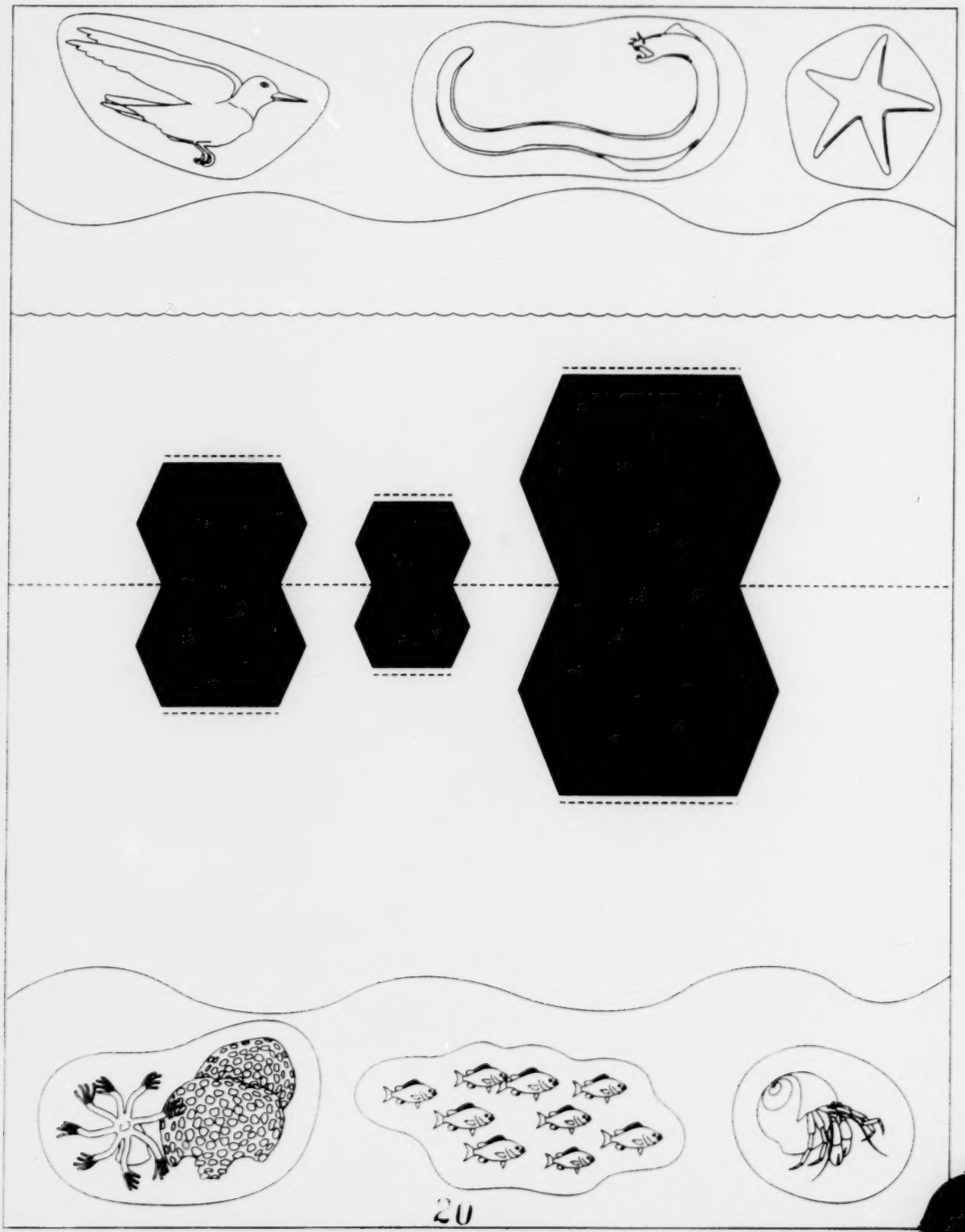
- Critter Cutouts on page 17
- construction paper
- scissors
- glue
- crayons, markers, or colored pencils
- a ruler



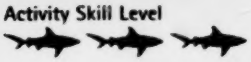
How to make your pop-up reef

1. Cut out the Critter Cutouts box that contains your reef and critters.
2. Cut along the wavy lines to separate the drawings of the reef animals from the reef and set the reef animals aside.
3. The area above the dashed center line is the sea and sky; the area below the dashed line is the ocean floor. Color each half as you would like.
4. With the printed side facing out, fold the page in half along the dashed line. Crease the fold with the edge of the ruler.
5. With the paper still folded, cut through both layers of the paper along all the solid sides of the rocks. Be sure not to cut through any dashed lines!
6. Open the page carefully. Gently pull the cut-out features toward you. Crease each pop-up feature along the folds and dashed lines to make it stand up. Then carefully close the pop-up with the reef folded forward.
7. Fold a piece of construction paper in half, creasing the fold with a ruler. Glue the reef to this page, matching the folds. Be sure not to glue the black pop-up rocks to the construction paper. Trim any extra paper from the top and the sides.
8. Close the reef with the pop-up features folded out and place under a heavy book to dry.
9. Color the reef animals you had set aside and cut them out.
10. Glue the reef animals to your background. Put some in caves, some on the seafloor, and some swimming or flying over the reef. To make some of the animals pop out, make a tab by folding a small piece of construction paper in half. The folded tab should be smaller than the animal so it doesn't show. Glue or tape one side of the tab to the animal and one side to the reef.
11. You can add more fish, corals, sponges, and seaweed to your reef. Be creative!

Critter Cutouts



Activity Skill Level



Ahoy! It's an Island

You've just discovered an uninhabited island! And what an island it is. It is surrounded by clean water full of plankton, fish, and other sea life. You call it Paradise Island! You don't own it, but because you found it, you have been appointed to watch over it.

Now that you are overseeing it, what will you let happen to it? Who will you bring in to help you out? (See Careers on page 32 for some ideas.) Some of the things you may want to do on the island are listed below. Read them, answer the questions, then use the island map to show your plan for this newfound paradise. And then check out What's Happening on page 34 below to see the potential impacts of your decisions.

I want to live on this island.

It certainly would be a beautiful place to live. Maybe you'll build a house. Or a campsite. Will you use toilets or outhouses? Where will you get fresh water? What will you use for power? How will you get food, building materials, and other supplies to the island? What will you do with the trash?

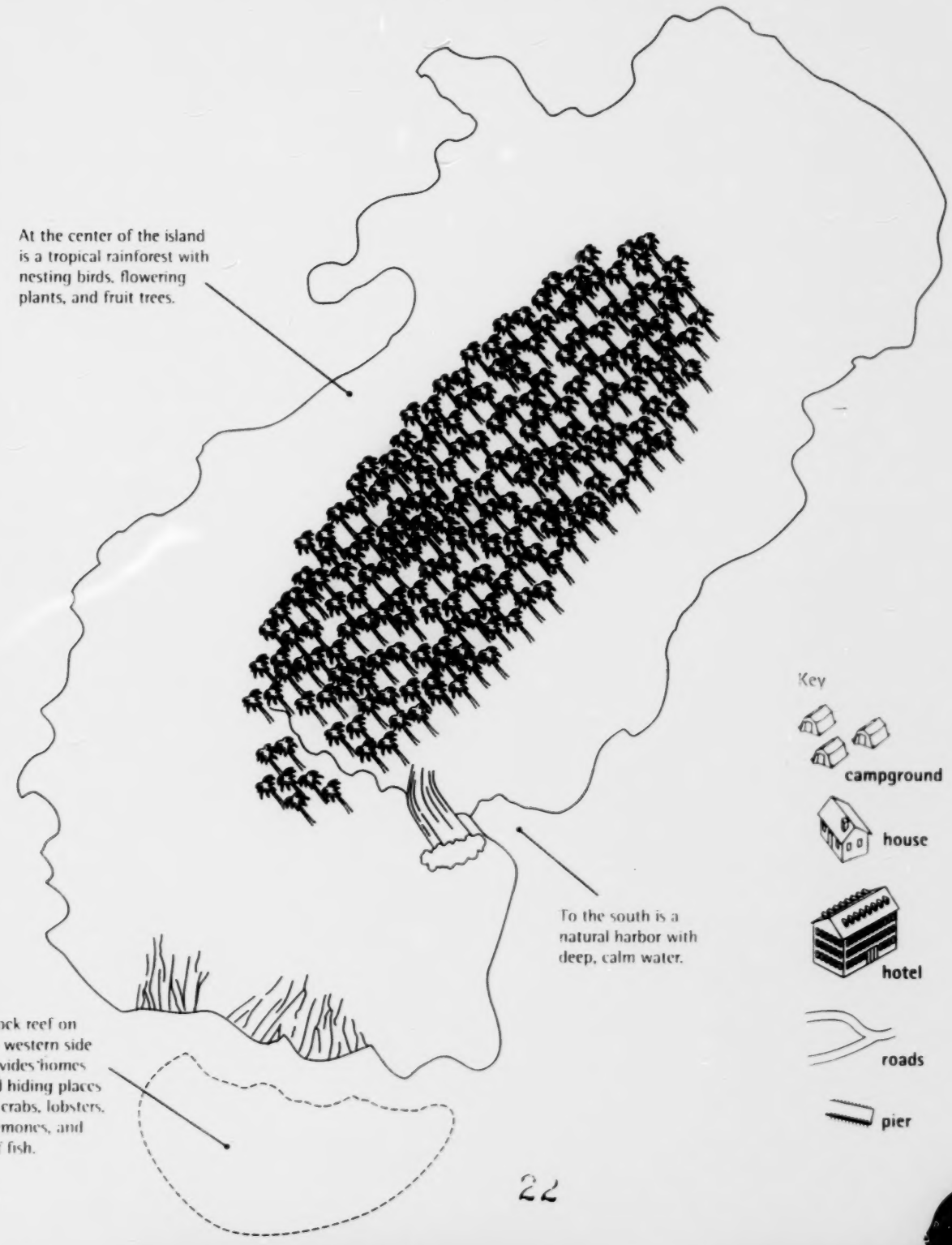
I want to make this island a nature preserve.

The island is perfect the way it is. What will you do to protect it from change? Will you write laws that prohibit fishing too close to shore? Will you put up "No Trespassing" signs? Will you hire a ranger to patrol the waters and make sure that no one comes ashore? How could you share the island's beauty with others without causing it harm? Would you allow researchers on the island to study its wildlife?

I want to make this island an adventure vacation center.

The island is a great spot for boating, snorkeling, diving, fishing, and hiking. How will you let people use your island? Will visitors come to the island for the day or will they stay overnight at a hotel? Where will you build the boat docks? Will you have bathrooms and a souvenir store? Where will you put the hiking trails? How will people get around? What rules will you have for divers, people who fish, and tourists? What will you do if a natural disaster strikes, like El Niño or a hurricane, and destroys the reef life or island life?

Paradise Island


At the center of the island is a tropical rainforest with nesting birds, flowering plants, and fruit trees.
To the south is a natural harbor with deep, calm water.
A rock reef on the western side provides homes and hiding places for crabs, lobsters, anemones, and reef fish.
Key
campground
house
hotel
roads
pier

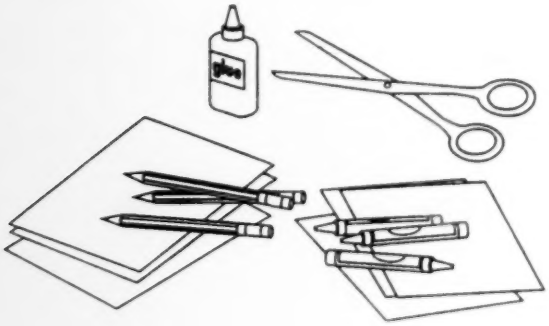
Activity Skill Level:

Take a Dive

Have you ever wondered what it would be like to scuba dive? What if you could dive around Cocos Island and the surrounding seamounts? What animals would you see? Here's an activity that will let you take a diving tour of the Cocos Island rock reef without ever getting wet!

What you'll need

- Creatures at Cocos on page 21
- Dive Field Guide on page 22
- construction paper
- glue
- scissors
- crayons, markers, or colored pencils



To make your diver's mask

1. Cut out the diver's mask pattern from the Creatures at Cocos page. Place it in the center of the sheet of construction paper and trace around it. Cut out the construction paper mask you have just traced.
2. Cut out the large square inside the mask by cutting along the dashed lines.
3. Glue the cutout mask window to your construction paper mask. Use a thin line of glue along the sides only.
4. Use crayons, markers, or colored pencils to decorate your mask.

To make your dive strip

1. Read your Dive Field Guide and then color the ocean backgrounds and animals on the dive strip on the Creatures at Cocos page.
2. After you have colored it, cut your dive strip out.
3. Glue it onto a piece of construction paper and cut it out once more.

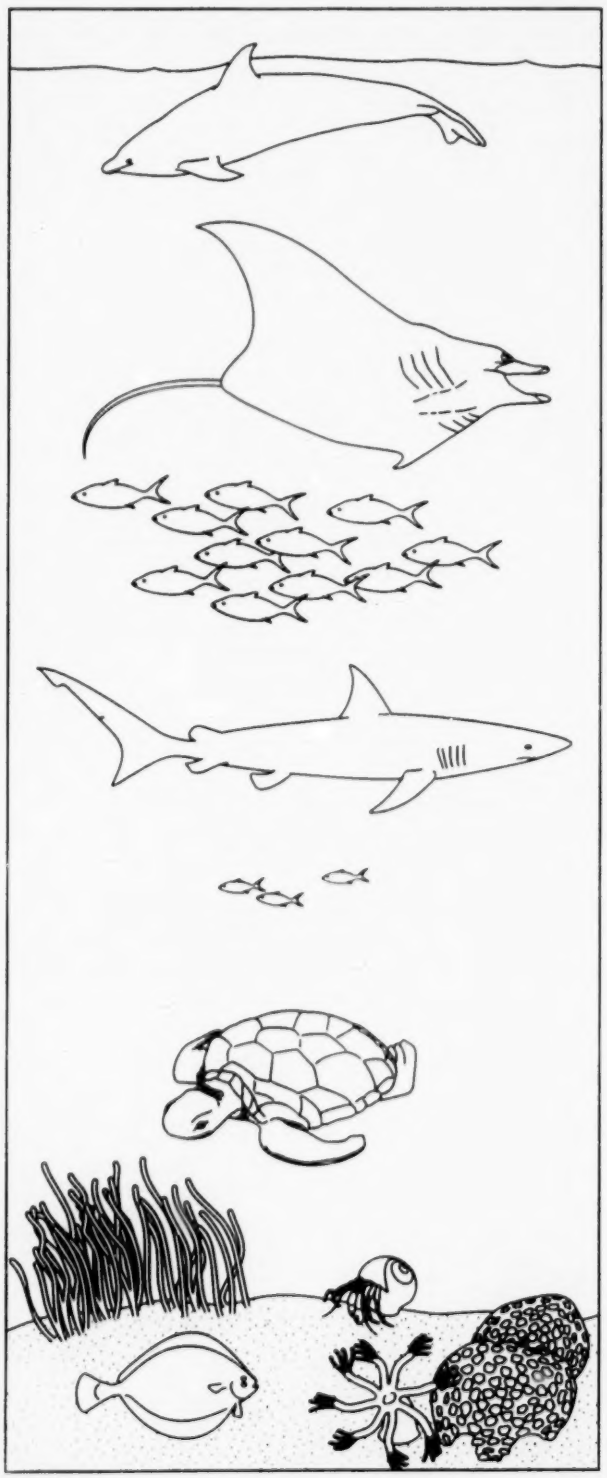
To take your dive

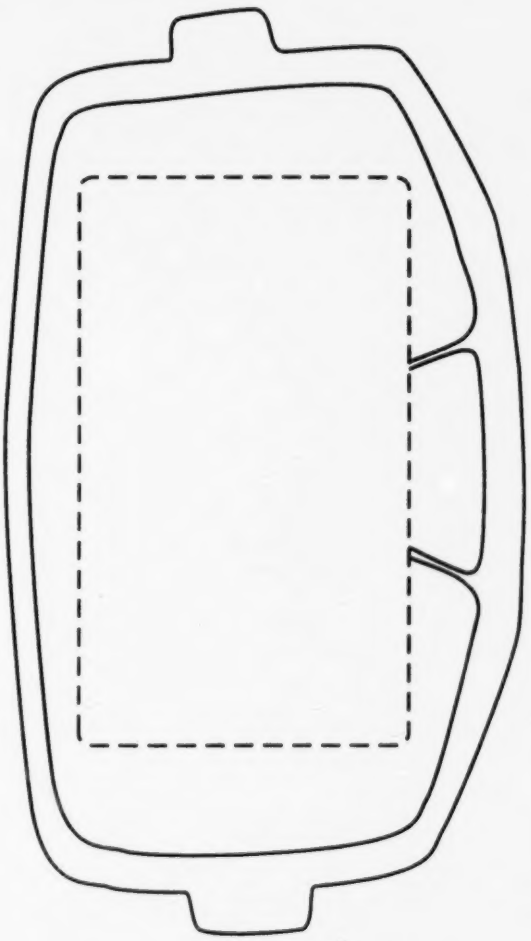
1. Insert the dive strip into the bottom of your mask, in between the front of the mask with the cutout and the construction paper back of the mask. Push the strip up until you can see the bottlenose dolphin through the window.
2. To take a dive, push the dive strip up through the top of the mask, again in between the two pieces of paper. Watch the animals change as you "swim" around the Cocos reef.

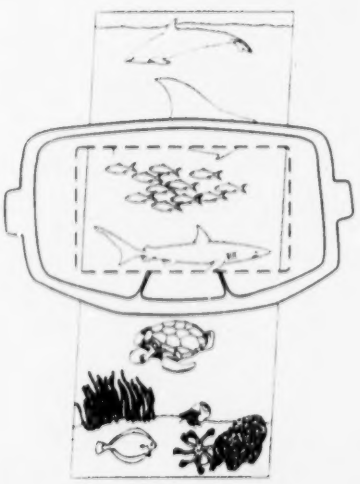
To learn about the Cocos ecosystem

1. Use your Dive Field Guide to help you identify the animals you see through the diver's mask window.
2. Once you've become familiar with some of the creatures that live on or visit the Cocos Island reef try this challenge: Figure out who eats whom on your dive strip. Write your predictions on a separate sheet of paper, then check What's Happening? on page 34 to see how you did.

Creatures at Cocos







24

Dive Field Guide

Here is a field guide to some of the animals you might see on a scuba dive trip off Cocos Island. While all of the animals are on the dive strip, you probably would not see all of these animals on a single dive.

1 Bottlenose Dolphin
- uses sharp teeth to catch prey
- dark to light gray back, white or pink underside
- mammal that grows up to 12 feet long

2 Manta Ray
- black back with a light underside
- "flies" through the water with large wing-like fins
- grows to 20 feet wide

3 Green Jacks
- fast silvery-green fish, about 1 to 3 feet long
- gather together in a ball shape to avoid predators
- valued as a food fish by other animals

4 Whitetip Shark
- moderately slender with broad and flattened head
- distinguished by white tip on top fin
- one of the most abundant reef sharks

5 Small Reef Fish
- variety of small fish that vary in color and shape
- serve as food for many other animals
- some are cleaners that groom other fish

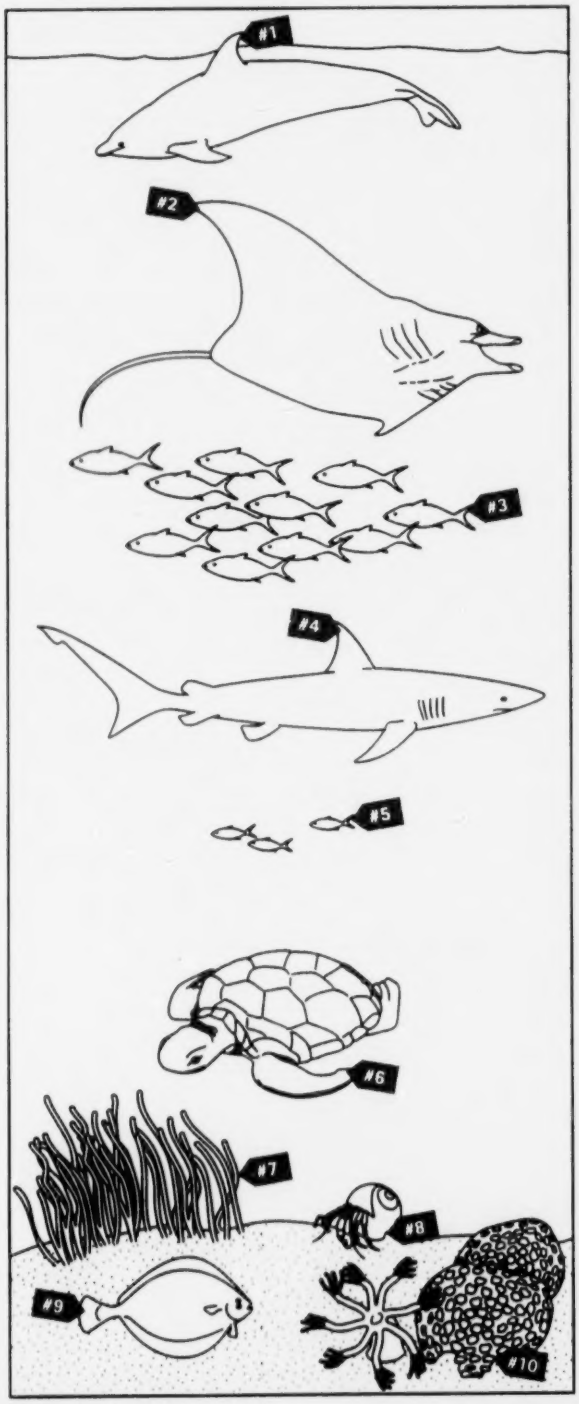
6 Green Sea Turtle
- migrates thousands of miles to breeding grounds
- brown back, light yellow underside
- moves through the water slowly

7 Seaweed
- grows on ocean bottom
- can be found floating in water
- comes in many different kinds

8 Hermit Crab
- lives in the empty shells of animals that have died
- front of body has claws and hard shell; back is soft
- moves into new, larger shells as it grows

9 Flounder
- bury in sand to hide
- skin is camouflaged to blend in with bottom
- eyes are on top of its head

10 Corals
- come in hard and soft varieties
- many contain algae that help them live
- their skeletons help build base of coral reef



Note: Animals not to scale.

All about Sharks

Some species of sharks were among the first creatures to live in the ocean. They existed more than 400 million years ago, 200 million years before dinosaurs. The most ancient sharks eventually became extinct, but descendants of sharks that swam in the age of dinosaurs are living today.

Did you know...

that sharks come in many shapes and sizes? Thresher sharks use their long tails to herd fish together before attacking them. The bottom-dwelling angelshark has a flat body with large, wing-like fins for gliding above the seafloor. Whale sharks are the largest fish in the world. They grow to lengths of 60 feet. The hammerhead is one of the strangest looking sharks. Look for its large eyes at each end of its hammer-shaped head.

Did you know...

that some sharks might use magnetism to help them find their way around? There is a magnetic mineral found in the molten lava that gushes from the earth's core. Two examples where this lava has come out having magnetic properties are mid-ocean ridges and underwater mountains known as seamounts. Some researchers believe sharks, especially hammerhead sharks, somehow use the magnetic marks of these two places—which are different—to help guide their travels. But no one is exactly sure if or how they do it..

Did you know...

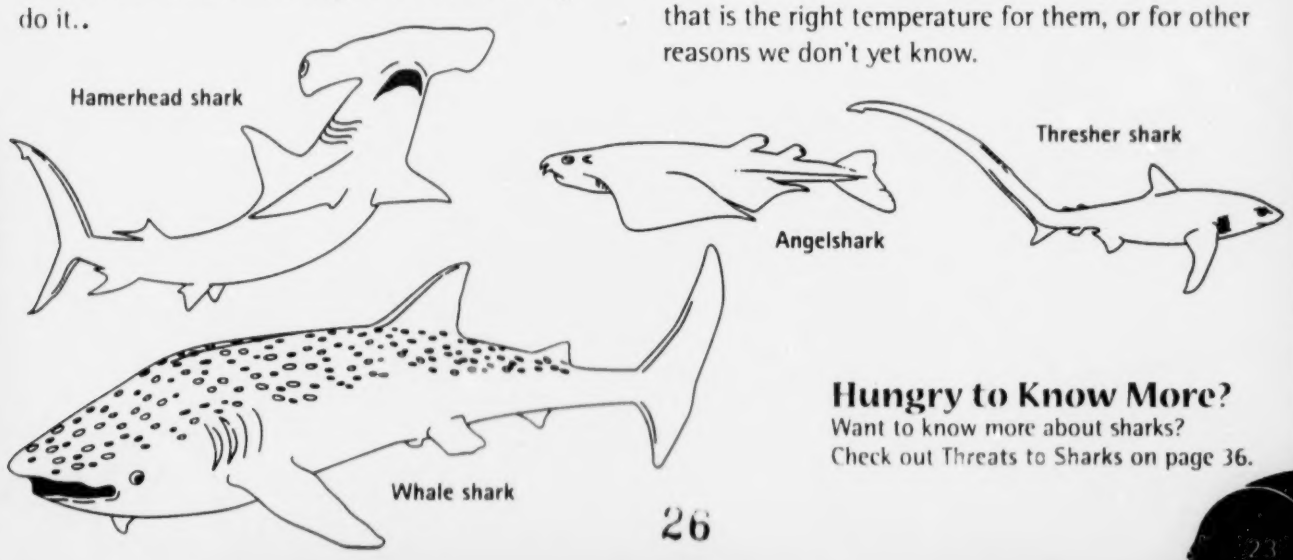
that not all sharks reproduce the same way? Some females carry their babies inside their bodies and give birth to live young, the way humans do. Other sharks lay an egg case in which the shark develops.

Did you know...

that of the more than 350 known species of shark, only a few are considered dangerous to humans? More than half of the world's sharks never grow to be more than 4 to 5 feet long and many have teeth too small to cause serious injury. People can swim safely with many kinds of sharks. Surprisingly, the largest sharks, whale sharks, are very gentle.

Did you know...

that some sharks don't always stay in one place? They travel, or migrate, from place to place in the ocean. They travel to find a mate or give birth to baby sharks, to find the food they like to eat, to make sure they stay in water that is the right temperature for them, or for other reasons we don't yet know.



Hungry to Know More?

Want to know more about sharks?
Check out Threats to Sharks on page 36.

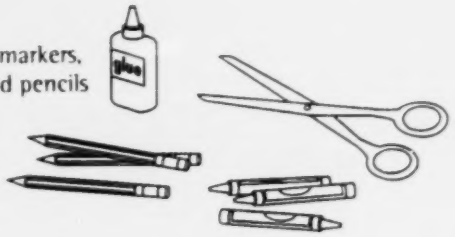
Activity Skill Level

Shark Parts

Sharks breathe and move around just like you do. But what do they use to do those things? You can find out by doing this puzzle.

What you'll need

- Shark Parts on this page
- scissors
- glue
- crayons, markers, or colored pencils



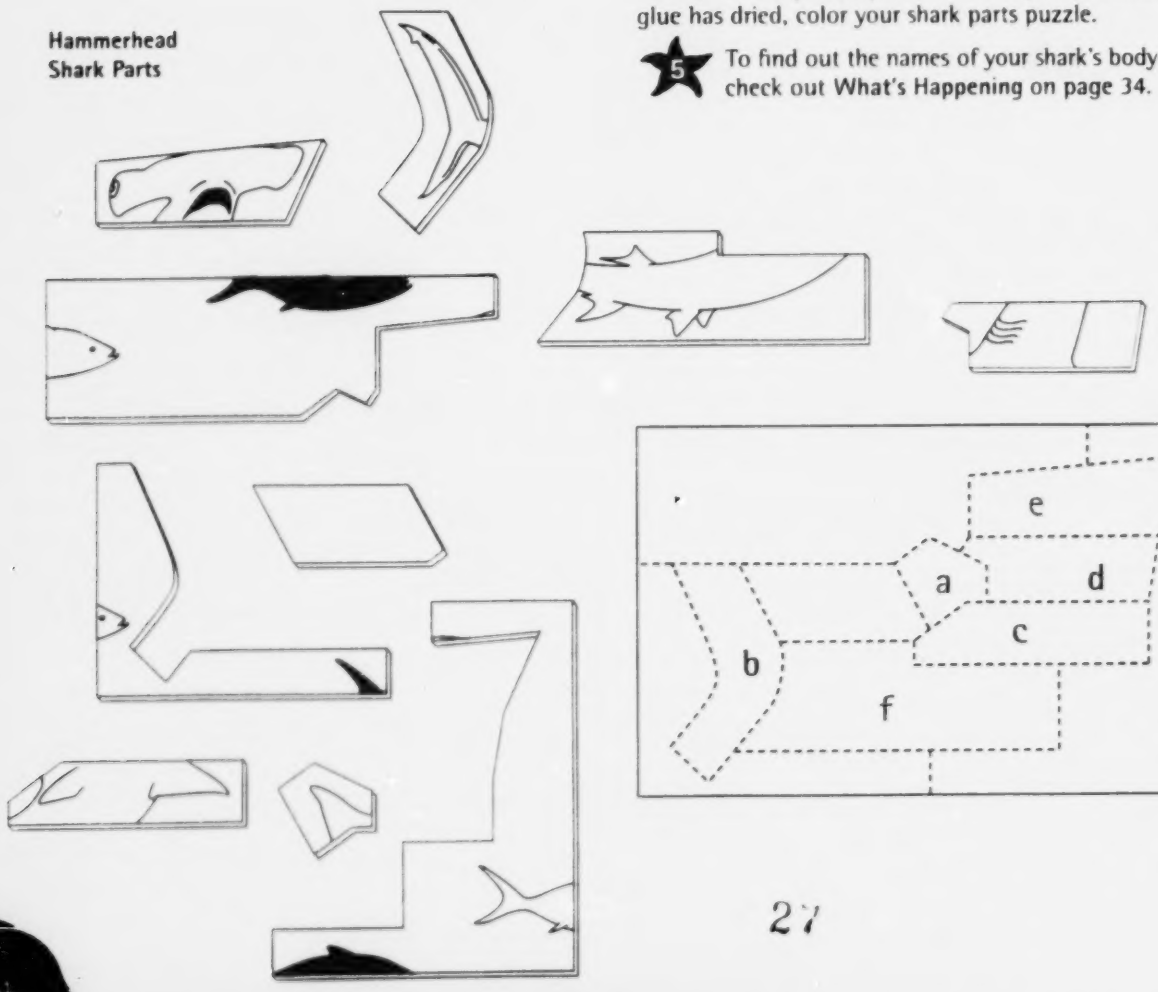
Putting your shark together

1. Read the questions that relate to a shark's body parts.
2. Cut out the puzzle pieces. Use them to answer the questions by placing the correct shark body part puzzle piece on the letter that goes with each question.

a What part balances a shark as it swims?
b What part gives the shark its swimming power?
c What gives a shark lift in the water and helps it steer?
d What enables a shark to breathe?
e What does a shark use to find and catch its food?
f What part contains the shark's stomach?

3. Once you've found the right body part, glue it to the puzzle pattern.
4. After you've put the shark together, glue the rest of the puzzle pieces into the pattern. Once the glue has dried, color your shark parts puzzle.
5. To find out the names of your shark's body parts, check out What's Happening on page 34.

Hammerhead Shark Parts



Activity Skill Level

A Dentist's Dream

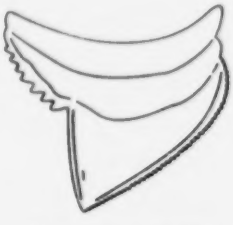
Sharks never need to go to the dentist because they grow new teeth throughout their lives. Look closely into the jaws of a shark (well, not too closely!). You will see several rows of teeth. If one tooth gets lost or broken, a new tooth moves up from behind to replace it. Most sharks produce thousands of teeth during their lifetimes.

Shark scientists have found something really cool: for sharks with triangular teeth, like the great white, you can use a simple mathematical formula to estimate a shark's size based on one tooth.

The length of the shark's body in feet is equal to about 10 times the length in inches of its largest tooth.

This means that if a shark tooth is ½ inch long, the shark that lost it was 10 times ½ (10 x .5) or 5 feet long. The formula can also be used in reverse. If a shark is 10 feet long, the formula estimates that each tooth will be 10 divided by 10 (10 ÷ 10) or 1 inch long. See if you can use these formulas to solve the two Shark Challenges. Check your answers in What's Happening on page 34.

Lemon Shark Tooth



Tiger Shark Tooth

Bull Shark Tooth

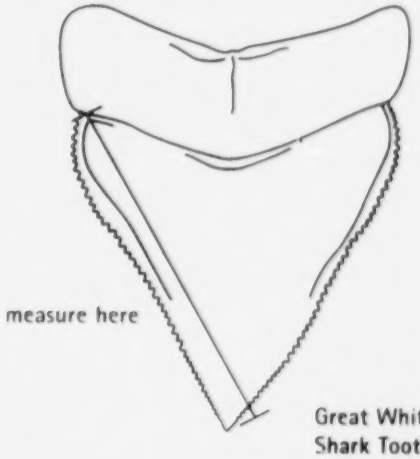
Sharks' Teeth
Sharks' teeth are adapted to the kind of food they eat. These pointed, sharp teeth all belong to predator sharks.

What you'll need

- **Great White Shark Tooth** on this page
- ruler or measuring tape

Shark Challenge #1

You are walking on the beach and find a tooth from a great white shark. Measure the length of the tooth along one side. How long is it? How big was the shark that lost it? How many kids standing side by side with their arms out would it take to show how big this shark was?



Great White Shark Tooth

Shark Challenge #2

From fossils, scientists estimate that ancestors of the great white shark were up to 80 feet long. How big were the teeth of these ancient giants? Once you've figured out the answer, draw an actual size picture of the prehistoric great white's tooth. How many kids standing side by side would it take to show the size of this primitive great white?

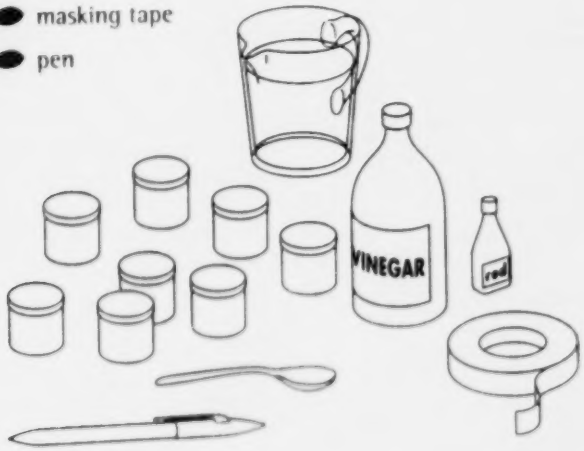
Activity Skill Level

Smelly? Not!

Smell is one of the first senses that come into play when a shark detects something in the water. How well can they smell? As well as you or better? Do this activity and find out.

What you'll need

- white distilled vinegar
- red food coloring
- eight small containers (bottles, cups, etc.) with lids or something to cover them
- tablespoon
- water
- masking tape
- pen



How to do your smell test

1. Mix a small amount (2 tablespoons) of vinegar with a few drops of red food coloring. This "blood" mixture is your starter solution. Set it aside.

Use the tablespoon to put nine tablespoonfulls of water in each container. Label each container with a number and the ratio of the solution (for example, 1:10 means 1 part vinegar—the blood—to 10 parts water each solution).

- **To prepare container 1,** add one tablespoonful of the starter solution in container 1 for a 1:10 solution.
- **To prepare container 2,** add one tablespoonful of the solution from container 1 for a 1:100 solution.
- **To prepare container 3,** add one tablespoonful of the solution from container 2 for a 1:1,000 solution.
- **To prepare container 4,** add one tablespoonful of the solution from container 3 for a 1:10,000 solution.
- **To prepare container 5,** add one tablespoonful of the solution from container 4 for a 1:100,000 solution.
- **To prepare container 6,** add one tablespoonful of the solution from container 5 for a 1:1,000,000 solution.
- **To prepare container 7,** add one tablespoonful of the solution from container 6 for a 1:10,000,000 solution.

2. Starting with container 7 smell each one of them separately down to container 1. Make sure to only have one open at a time.

3. After you have smelled each container, write down whether you could smell the vinegar. Then write down which one you think a shark could smell. Check out What's Happening on page 34 when you're done.

Shark Smell

Depending on several things, a shark can smell blood hundreds of yards away. A shark's nose is for smelling only and not used to help it breathe like yours. Hammerhead sharks have nostrils on the sides of their heads. The wide spacing may help these sharks detect smells from great distances as the sharks swing their heads from side to side.

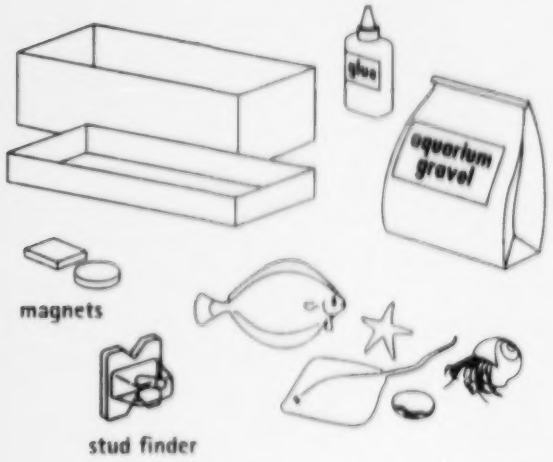
Activity Skill Level

Fishing for Dinner

All living things (even you) produce an electric field, given off by each heartbeat or muscle movement. A shark has special receptors around its head that can detect these small electric fields. They help a shark find a fish or animal hidden in the sand. Rays and sharks are members of the same family. Both can sense electrical signals. Do this activity where you pretend you are the ray and see how this sense works.

What you'll need

- shoebox
- sand or fine aquarium gravel
- ½-inch to 1-inch round or square flat magnets
- plastic toy figures or cardboard cutouts of a flounder, clam, hermit crab, starfish, and sting ray
- glue
- plastic stud finder (available at hardware stores)



How to make and use your creature finder

1. Fill the shoebox with about an inch of sand or aquarium gravel.
2. Use the glue to attach the magnets to your plastic figures or cardboard cutouts of the flounder, clam, hermit crab, and starfish.
3. Use the glue to attach your sting ray to the bottom of the stud finder (where the magnet is). Let the glue dry a few minutes before going onto the next step.
4. Hide, or have someone hide, your sea creatures in the sand or aquarium gravel. Slowly move your sting ray over the sand until the rod in the stud finder moves. When it does, the ray has located its dinner!
5. See if your ray can find all the hidden creatures.
6. How do you think this sense helps rays and sharks catch their dinner? What might happen if sharks didn't have this sense?

Shark Electroreception

This sense that some sharks (and rays) have is called electroreception. Sharks use special organs called ampullae of Lorenzini to detect tiny electrical impulses given off by fish and other animals. These organs look like tiny pits or pores. They are found mostly on its head.

Activity Skill Level

Shark Folklore

What do most people feel when they hear the word SHARK? Probably fear. But not all people are afraid of sharks. In fact, in some parts of the world, where people fish and swim with sharks every day, sharks are honored and sometimes worshipped as gods. The sharks of many Polynesian island legends are not like the killer shark of the movie "Jaws." They are sharks like the Hawaiian shark king, Kama-Hoa-Lii, who, with the help of the powerful shark Kalahiki, was thought to be the protector of fishermen in danger. Here's a Hawaiian legend about a very special shark. Read it to yourself or with friends. How does this legend make you feel?

After you have read the story, draw pictures of your favorite parts. Then use **Create a Legend** on page 30 to make up a legend with drawings of your own to share with your friends—just like people from ancient cultures.

The Shark Guardian

This is a story of the days when Mary Kawena Pūku'i was a little girl in Ka-'ū on Hawai'i. One very rainy day she got to thinking of a certain kind of fish. "I want *nenue* fish," she said.

"Hush child," her mother answered. "We have none."

"But I am hungry for *nenue* fish!" the little girl repeated and began to cry.

"Stop your crying!" said another woman crossly. "Don't you see we can't go fishing today? Just look out at the pouring rain. No one can get you *nenue* fish. Keep still!"

The little girl went off into a corner and cried softly so that no one should hear, "I do want *nenue* fish! Why can't someone get it for me?"

Her aunt came in out of the rain. It was Kawena's merry young aunt who was always ready for adventure. "What is the matter with the child?" she was asking. "The skies are shedding tears enough, Kawena. Why do you add more?"

"I want *nenue* fish," the little girl whispered.

"Then you shall have some. The rain is growing less. We will go to my uncle."

In a moment the little girl had put on her raincoat, and the two were walking through the lessening rain. It was fun to be out with this merry aunt, fun to slip on wet rock, and shake the drops from dripping bushes.

At last they reached the uncle's cave. "Aloha!" the old man called. "What brings you two this rainy morning?"

"The grandchild is hungry for *nenue* fish," Kawena's aunt replied.

"And *nenue* fish she shall have," said the old man. Net in hand he climbed the rocks above his cave home. Kawena and her aunt watched him as he stood looking out over the bay. He stood there like a man of wood until the little girl grew tired watching. The rain had stopped and sunlight touched the silent figure. Why didn't he do something? Why didn't he get her fish? Why did he stand there so long—so long?

Suddenly he moved. With quick leaps he made his way to the beach and waded out. Kawena and her aunt hurried after him and saw him draw his net about some fish and lift them from the water. Just as the girl and woman reached the beach the old man held up a fish. "The first for you, old one," he said and threw the fish into the bay. A shark rose from the water to seize it. "These for the grandchild," the old man added. He was still speaking to the shark as he gave four fish to Kawena.

The little girl took her fish, but her wondering eyes were following the shark as he swam away.

"That is our guardian," the uncle said. He too was watching the shark until it disappeared.

"Tell her about our guardian," said the aunt. "Kawena ought to know that story."

"The Shark Guardian" story and artwork reprinted with permission from *Tales of the Menehune (Revised Edition)*, compiled by Mary Kawena Pūku'i; retold by Caroline Curtis; illustrated by Robin Burningham. Kamehameha Schools Press: Honolulu. Copyright 1985 by Kamehameha Schools Bishop Estate.

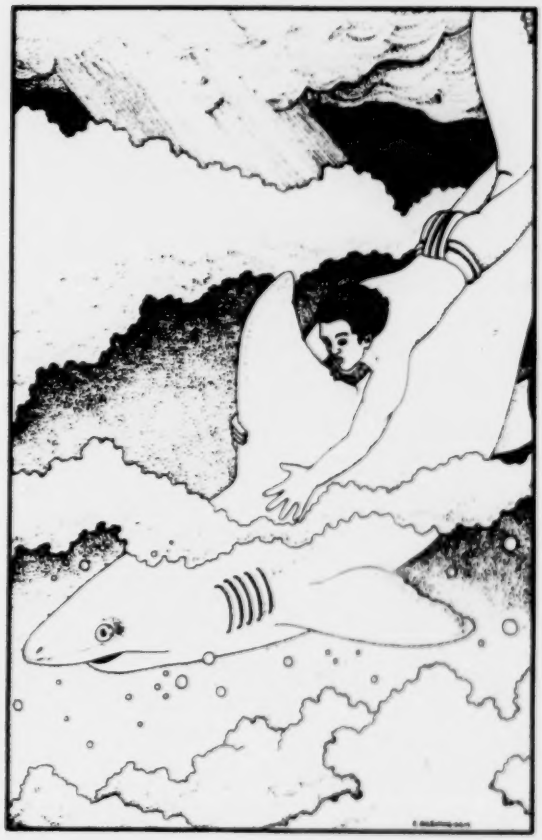
Shark Folklore

The uncle led them back to his cave. There, dry and comfortable, they sat looking down at the beach and the bay. "It was from those rocks that I first saw him." The uncle began, his eyes on rocks below.

"One day, many years ago, I found my older brother lying on the sand. For a moment I thought that he was dead. Then he opened his eyes and saw me. 'Bring *'awa* and bananas,' he whispered. I stood looking at him, not understanding his strange words. After a bit he opened his eyes again and saw me still beside him. "'*Awa* and bananas!' he repeated. 'Get them quickly.'

"As I started away I saw him pull himself to his feet, holding onto a rock. He looked out over the bay and called, 'Wait, O my guardian! The boy has gone for food.' Then he sank back upon the sand. I looked out into the bay, but saw no one.

"I got *'awa* drink and ripe bananas and brought them to my brother. He pulled himself weakly to his feet once more and moved out onto those rocks, motioning me to bring the food. He called again and his voice was stronger. 'O my guardian, come! Here is *'awa* drink! Here are bananas! Come and eat.'



"Suddenly a large shark appeared just below the rocks on which we stood. As my brother raised the wooden bowl of *'awa*, the great fish opened his mouth. Carefully my brother poured the drink into that open mouth till all was gone. Then he peeled the bananas one by one and tossed them to the shark, until the great fish was satisfied. 'I thank you, O my guardian!' Brother said. 'Today you saved my life. Come here when you are hungry.' The shark turned and swam away.

"While my brother rested on the sand he told me his adventure. His canoe had been caught in a squall and overturned. He was blinded by rain and waves and could not find the canoe. It must have drifted away. The waves broke over him and he thought the end had come.

"Then he felt himself on something firm. 'A rock!' he thought and clung to it. Suddenly he felt himself moving through the waves and knew that he was riding on the back of a great shark and clinging to his fin. He was frightened, but kept his hold.

"The storm passed on, and my brother saw the beach. The shark swam into shallow water, and Brother stumbled up the sand. It was there I found him.

"He never forgot that shark. Often I have seen him standing on the rocks above this cave with *'awa* and bananas ready. Sometimes he called. Sometimes he waited quietly until the shark saw him and came. Sometimes the shark drove a small school of fish into the bay as you saw just now. My brother caught some and shared them with the shark.

"The time came when my brother was very sick. Before he died he beckoned to me. 'My guardian,' he whispered. 'You must give food to the one that saved my life.'

"I have not forgotten, and the shark does not forget. I feed him *'awa* and bananas, and he sometimes drives fish into my net. Today he wanted *nenue* fish and put the thought of them into your mind. Always remember our guardian, Kawena."

Kawena Pūku'i is a woman now, but she has never forgotten the shark guardian.

–Told by Mary Kawena Pūku'i

Create a Legend

Now use this page to make up your own legend.
Illustrate it with your own drawings.

Resources

Career Information

Interested in finding out more about marine science careers? Try these places.

Marine Science Careers: A Sea Grant Guide to Ocean Opportunities

Produced in 1996 by the National Sea Grant Program, this 40-page booklet is a compilation of interviews with 38 people who work in the marine sciences. Occupations vary from marine biologist to naval architect to lifeguard. For a copy of the printed publication, contact your local Sea Grant office or mail a $5 check payable to WHOI to:

Sea Grant Communications Office
Woods Hole Oceanographic Institution
193 Oyster Pond Road, CRL 209
Woods Hole, MA 02543-1525
(508) 289-2665

Stanford University

Careers and Jobs in Marine Biology and Oceanography
www-marine.stanford.edu/hmsweb/careers.html
This Web site provides more than 15 links to other sites with marine science careers information, and connections to Web pages with postings for jobs, traineeships, and internships specific to the marine and aquatic sciences.

Scripps Institution of Oceanography

So You Want to Become a Marine Biologist...
www-siograddept.ucsd.edu/Web/To_Be_A_Marine_Biologist.html
A former Scripps Institution of Oceanography graduate student provides his thoughts about a variety of topics, including what classes to take, how many hours a typical workday might include, and what entry level pay might be for a marine biologist.

University of New Hampshire

Careers in Marine Science
bioscience.unh.edu/career/Careers.html
People tell about the options and opportunities in their careers that include jobs in aquariums, fisheries, biology, government, and medicine.

Want to Do More?

Can't wait to get involved? Take a class. Become a volunteer. Or join a club or organization that studies or protects ocean life. Most organizations have a newsletter or magazine for members with up-to-date information on how you can help.

Many aquariums have volunteer programs that give you a chance to try out different jobs by helping the aquarium staff. Volunteers can be gallery guides who answer visitors' questions or give tours. Or they may help out with the animals, preparing food and cleaning tanks. Usually no prior training is required. Students can also get involved as volunteers on research projects. Many colleges and universities or state agencies have community monitoring programs.

Call your local aquarium or college to learn about volunteer opportunities.

Want to Know More?

Looking for some more information about the ocean? Try these Web sites.

New England Aquarium

www.neaq.org/

National Oceanic and Atmospheric Administration

www.noaa.gov/

National Marine Fisheries Service

www.nmfs.gov/

NOVA Online

www.pbs.org/nova/sharks/

For more shark folklore, check out these books:
Hawai'i Island Legends: Pīkoi, Pele and Others by Mary Kawena Pūku'i and Caroline Curtis. Illustrated by Don Robinson. Favorite legends of the hero Pīkoi, the goddess Pele, and other folk of the Big Island. Suitable to be read to younger children and read independently by older children and adults. Honolulu: Kamehameha Schools Press. 1996. 250 pp.

The Water of Kāne and Other Legends of the Hawaiian Islands (revised edition) by Mary Kawena Pūku'i and Caroline Curtis. Illustrated by Oliver C. Kinney. The lore of 'Aukele, who stole the magical "water of Kāne" to revive his dead nephew and brothers, along with a host of other folktales from the islands of Hawai'i. Suitable to be read to younger children and read independently by older children and adults. Honolulu: Kamehameha Schools Press. 1994. 221 pp.

Careers

Many people who love the ocean and sea life have jobs that let them study or work to protect the sea and its creatures. Here are some ocean-related careers you might find interesting.

Marine Biologist: Do you want to know more about ocean life? Be a marine biologist! These scientists study the animals and plants that live in the ocean. Some marine biologists study just one type of animal, trying to learn everything possible about where it lives and how it survives. Others study an entire ecosystem to understand how different plants and animals get along in their habitat and with each other.

Professional Diver: There are many different and unusual jobs for professional scuba divers. They may help salvage shipwrecks, inspect underwater supports for bridges, or serve as underwater guides for tourists on a reef. Professional divers need special training and sometimes work under dangerous conditions.

Geologist: Are you fascinated by volcanoes, earthquakes, and undersea mountain ranges? Or do you just like to collect rocks? Geologists are scientists who study layers of rock and soil to learn more about how the earth has changed over the past hundreds of millions of years. Geologists are the scientists who discovered how seamounts are formed. They are also trying to learn more about how rocks in the seafloor help ocean animals to navigate.

Aquarium Staff: Aquariums employ scientists to care for their animals, artists to design their exhibits, teachers to present school programs, and business people to raise money and pay the bills. Working at an aquarium is a great way to get close to live animals and share a love of marine science with others.

Environmentalist: Do you feel strongly about protecting ocean habitats and animals? Then a career as an environmentalist would be good for you. Some environmentalists help to save the oceans by making speeches or writing articles that make people aware of environmental problems. Others raise money that can be used to buy and conserve special coastal areas or to fund environmental research.

Coastal Zone Manager: Sometimes protecting the ocean requires someone who can make tough decisions and enforce rules. Coastal zone managers are planners and lawmakers who work to protect the coast and the ocean from human impacts like construction and water pollution. Some work for the federal government in Washington, DC, making decisions that affect the whole country. Others work for states or for cities and towns.

Michelle Heupel
Marine Biologist

Job: Postdoctoral scientist at Mote Marine Laboratory's Center for Shark Research in Sarasota, Florida

Duties: Planning experiments, choosing and designing equipment, conducting field work, and analyzing study results.

Research projects: Michelle is currently researching the movements and distribution of newborn and juvenile blacktip sharks in a coastal nursery area. She is responsible for catching sharks, attaching transmitters to them, and tracking them in a small boat. Michelle is trying to find out how much of the day these young sharks spend in their nursery area and how often they leave the area in an effort to understand why they choose to stay in one place or another.

Education: B.Sc. Zoology; Post Graduate Diploma Marine Science; Ph.D. Marine Science

Advice for beginners: "If this is what you really want to do stick with it and don't let anyone tell you that you can't do it. I am from Colorado, nowhere near the ocean, and when I finished high school I was told I would never get to be a shark biologist, so I should give it up. I refused to give up and worked hard to get to be a scientist and study sharks."

The coolest thing about the job: "The coolest thing about my job is getting to learn new things about these animals. I love getting to tell others what I found so we can all understand sharks better in the future and use our knowledge to protect our environment and the animals in it."

Careers

Darryl Keith
Oceanographer

Job: Oceanographer with the U.S. Environmental Protection Agency in Narragansett, Rhode Island

Duties: Preparing research plans for oceanography cruises to study environmental conditions in estuaries and coastal waters. Activities include water sampling, light measurements, and sediment collection.

Research projects: Darryl is currently using satellite data and photographs to learn more about where high concentrations of phytoplankton are found in coastal waters. For another project, he dove in submersibles to study containers of chemical and radioactive wastes that had been dumped in the ocean.

Education: B.A. Geology; M.S. Geological Oceanography; Master in Marine Affairs; Ph.D. Candidate Biological Oceanography.

Advice for beginners: "Read a lot about the ocean. Watch television specials about ocean explorers. Develop an understanding of mathematics and science and the beauty of nature because it all links together."

The coolest thing about the job: "Being outdoors and seeing beautiful sunrises and sunsets. Using 'neat' scientific technology like submersibles and undersea robots. Traveling and meeting nice people."

Daniel L. Rudnick
Oceanographer

Job: Associate professor of oceanography at University of California's Scripps Institution of Oceanography in San Diego

Duties: Teaching and doing ocean research. Activities include developing instruments, making measurements at sea, and analyzing data.

Research projects: Dan is currently doing research with SeaSoar, a small underwater plane equipped with instruments that include sensors to measure temperature and salinity. He tows SeaSoar behind a ship to search for systems of warm and cold water in the ocean.

Education: B.A. Physics; Ph.D. Oceanography

Advice for beginners: "Take courses in mathematics, biology, physics, and chemistry, go to college, and learn a lot about a science that interests you. Get wet if you can. The best way to learn about the ocean is to observe it."

The coolest thing about the job: "The best thing is when you go out to sea and measure something no one has ever observed before. It's the thrill of discovery!"

Oceanographer: If you like to get your hands wet, this could be the job for you. Oceanographers are scientists who study the physical features of the ocean—the currents, waves, tides, and the sea floor. Many oceanographers spend months at sea taking measurements and collecting data from research vessels that travel all over the world.

Science Journalist: Exciting, new facts are being learned about the ocean and ocean life everyday. Science journalists report on undersea explorations, amazing animal discoveries, and ecosystem research. They can produce documentary films, write stories for newspapers or magazines, or represent scientific organizations.

Politician: Mayors, governors, representatives, senators, and even the president make decisions every day that affect the world's oceans. Most politicians are not scientists. They use information they are given by others to make these decisions. Some politicians have assistants to help them with science problems. Politicians also listen to voters who call or write with good ideas about how the oceans can be preserved.

What's Happening

Page 12—Ocean Motion

Cold/salty water is more dense than warm fresh water because the molecules that make up the water are packed more closely together. This is why your ice water and salt mixture moved underneath the lukewarm water in this experiment. In the ocean, water which is more dense will sink into the deep sea. This water movement is called thermohaline, "thermo" meaning temperature, and "haline" meaning saltiness. An example of this movement occurs when warm water carried north by the Gulf Stream is cooled in the North Atlantic. This cooler water then sinks and moves along the ocean bottom.

Page 14—Sea around You

From the Sea

Pearl Necklace—When an oyster can't get rid of a scratchy piece of sand inside its shell, it turns it into a pearl. Oysters make pearls by coating a grain of sand or other irritant with the same material they use to build their shells, called nacre. Most pearls we use today are not from the wild. They come from oysters that are specially raised to make pearls for jewelry.

Seahorse Key Chain—Seahorses are killed and dried to make decorations like these. Collecting seahorses as souvenirs threatens seahorse survival.

Salt—One hundred years ago, most of the salt used for cooking was made by evaporating sea water. Today, you can still buy sea salt in stores, but most table salt is made by combining chemicals in a laboratory.

Shark Fin Soup—Is there really shark fin soup? Yes, and it includes real shark fins. Shark finning (catching shark for their fins and then throwing away the rest of the injured shark) is one of the activities that is threatening shark populations today. This practice is illegal in the United States but not in some other countries.

Sponges—You probably have sponges in your house. If they are green, yellow, orange, or pink, only the design came from the sea. Natural sea sponges are brown and lumpy. Natural sponges have many uses, including for painting and bathing. Sponges are actually animals; while alive, they feed by filtering living and dead organic matter from the water.

Toothpaste and Ice Cream—Bet you didn't know that many brands of toothpaste and some ice creams use an extract of seaweed, or carrageenan, as a thickener.

Not from the Sea

Items not from the sea include the steak, the pepper, the toothbrush, the purse, and the celery.

Page 18—Ahoy It's an Island

All of the ideas could work, with planning. But some could change the island so much that it will no longer be a paradise.

Living on the island would cause the most changes. Would you have room for a hotel without cutting down the rainforest? Perhaps you could build a small house or two, but a campsite would keep the island most natural. Trash (and sewage) could be composted or taken off the island by boat. Rainwater could be captured in cisterns or distilled from ocean water. Outhouses would have to be designed to keep sewage out of the water. Bikes and mopeds would be able to travel the natural pathways, but cars would require new roads. Batteries, generators, solar energy, or gas cylinders could be used for power.

An adventure vacation center would need to be carefully designed. The challenge will be to let people enjoy the island without causing harm. Fishing could be restricted to prevent overfishing. You could ban dive boat operators from anchoring, and install permanent moorings at popular dive sites instead. Divers and hikers could be instructed not to collect shells, corals, and rainforest plants. All trash hiked in could be hiked out. There would be no need for a souvenir store. Visitors could take home photographs and memories.

A nature preserve is the best plan if you want to protect the island from change. Cocos is a World Heritage site and a Costa Rican National Park, which means that the National Park Service protects and maintains the wildlife there. But you will need money to pay the park ranger and may need to set rules for the research scientists. You may be able to pass laws that prohibit fishing near the island, or preserves could be designated among parts of the island, but you will not be able to control what happens to migrating animals when they swim outside of the preserve. Who is responsible for animals that don't always live within any one country's borders? And you may not allow dumping or other pollution in the preserve, but how will you protect the island from disasters like oil spills, which may travel far enough to reach your island?

Page 20—Take a Dive

Few of the creatures that live on a reef eat only one kind of food; most eat a variety of foods, just like you do. Usually, the larger animals eat the smaller ones—here is just a sampling of who on the strip might eat whom:

1 **Bottlenose dolphin** eats small reef fish and green jacks.

2 **Manta ray** eats plankton.

3 **Green jacks** eat small reef fish.

4 **Whitetip shark** eats small reef fish, flounder, and green jack.

5 **Small reef fish** eat plankton (which would probably be too small for you to see on your dive) and other small reef fish.

6 **Green sea turtle** eats seaweed.

7 **Seaweed** uses the sun's energy to grow.

8 **Hermit crab** eats anything that has died or is left over from some other creature's dinner.

9 **Flounder** eats small reef fish.

10 Some **corals** eat plankton; algae within many corals uses the sun's energy to grow.

Page 24—Shark Parts

a What part balances a shark as it swims?
dorsal fin

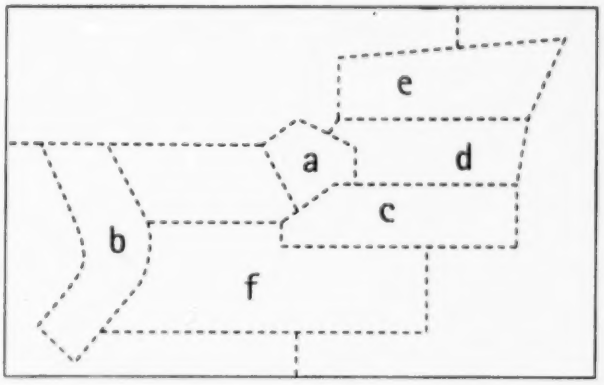
b What part gives the shark its swimming power?
caudal fin

c What gives a shark lift in the water and helps it steer?
pectoral fins

d What enables a shark to breathe?
gills

e What does a shark use to find and catch its food?
Ampullae of Lorenzini and teeth

f What part contains the shark's stomach?
midsection



Page 25—A Dentist's Dream

If x = length of the shark in feet and y = the length of the tooth in inches, the formulas look like this: $x = 10 \times y$ and $y = x \div 10$. **Shark Challenge 1:** 10 x 2, or 20 feet; **Shark Challenge 2:** 80 ÷ 10 or 8 inches along each edge.

Page 26—Smelly? Not!

Sharks can detect a concentration of some chemicals as low as 1:1,000,000 (one part per million, container 6); you could probably only smell the vinegar in the solution with one part per 100 (container 2). The shark's sense of smell is 10,000 times more powerful. It is most sensitive to chemicals found in the food it usually eats.

Threats to Sharks

People hunt sharks for their meat, oil, fins, cartilage, and for sport. If too many sharks are killed, there may not be enough left for the population to reproduce and survive. To protect some shark species, fisheries scientists are putting limits on the number that can be caught. If sharks are overfished, underwater ecosystems will be thrown out of balance. Sharks are also at risk because they take a long time to mature and give birth to few offspring—some sharks take up to 12 years to reach adulthood and many species only give birth to one to two pups at a time.

Want to know more about sharks themselves, what's happening to them, or ways to help protect them? Contact the organizations listed below.

Florida Museum of Natural History
Shark Research Program
www.flmnh.ufl.edu/fish/research/
Provides information about recent shark news, shark newsletters, shark attacks worldwide, recommendations for children's shark and general reference books, and links to other shark sites.

George H. Burgess
Director, International Shark Attack File
Florida Museum of Natural History
University of Florida
Gainesville, Florida 32611
e-mail: gburgess@flmnh.ufl.edu

International Union for Conservation of Nature and Natural Resources (IUCN)
Shark Specialist Group
www.flmnh.ufl.edu/fish/research/IUCN/
The IUCN is an umbrella organization of governmental and non-governmental world conservation agencies and institutions. The Web site includes a newsletter and recent shark news updates. The newsletter publishes articles dealing with shark, skate, ray and chimaeroid fisheries, conservation, and populations.

Newsletter Editor and Shark Specialist Group Co-Chair
Sarah Fowler
The Nature Conservation Bureau Ltd
36 Kingfisher Court
Hambridge Road
Newbury, Berkshire, RG14 5SJ, UK
e-mail: sarahfowler@naturebureau.co.uk

Shark Trust
ds.dial.pipex.com/sharktrust/
Promotes the study, management, and conservation of sharks, skates, and rays. Web site includes descriptive, biological, and distribution information and illustrations for more than 50 species of sharks.

Shark Trust
36 Kingfisher Court
Hambridge Road
Newbury, Berkshire, RG14 5SJ, UK

Shark Foundation
www.shark.ch/home.shtml
Contains facts about shark threats; a gallery of shark photographs; and an extensive shark database providing information about shark appearance, size, reproduction, endangerment, and more.

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